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RCRA Facility Investigation-Remedial Investigation/ Corrective Measures Study-Feasibility Study Report for the Rocky Flats Environmental Technology Site Appendix A – Comprehensive Risk Assessment

Volume 4 of 15
Risk Assessment for the Rock Creek Drainage Exposure Unit

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for the U.S. Department of Energy

October 2005

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ACRONYMS AND ABBREVIATIONS

µg/kg	microgram per kilogram
µg/L	microgram per liter
AEU	Aquatic Exposure Unit
AI	adequate intake
bgs	below ground surface
BZ	Buffer Zone
CAD/ROD	Corrective Action Decision/Record of Decision
CD	compact disc
CDPHE	Colorado Department of Public Health and Environment
CMS	Corrective Measures Study
CNHP	Colorado Natural Heritage Program
COC	contaminant of concern
CRA	Comprehensive Risk Assessment
DOE	U.S. Department of Energy
DQA	Data Quality Assessment
DQO	data quality objective
DRI	dietary reference intake
ECOI	ecological contaminant of interest
ECOPC	ecological contaminant of potential concern
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ERA	Ecological Risk Assessment
ESL	ecological screening level

EU	Exposure Unit
HHRA	Human Health Risk Assessment
HRR	Historical Release Report
IA	Industrial Area
IAG	Interagency Agreement
IDEU	Inter-Drainage Exposure Unit
IHSS	Individual Hazardous Substance Site
K-H	Kaiser-Hill Company, L.L.C.
MDC	maximum detected concentration
mg	milligram
mg/day	milligram per day
N/A	not applicable or not available
NFAA	No Further Accelerated Action
NOAEL	no observed adverse effect level
NWTC	National Wind Technology Center
OU	Operable Unit
PAC	Potential Area of Concern
PCOC	potential contaminant of concern
PMJM	Preble's meadow jumping mouse
PRG	preliminary remediation goal
QA/QC	quality assurance/quality control
QAPjP	Quality Assurance Project Plan
RCEU	Rock Creek Drainage Exposure Unit
RCRA	Resource Conservation and Recovery Act
RDA	recommended daily allowance

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RDI	recommended daily intake
RFCA	Rocky Flats Cleanup Agreement
RFETS	Rocky Flats Environmental Technology Site
RI/FS	Remedial Investigation/Feasibility Study
SAP	Sampling and Analysis Plan
SCM	site conceptual model
tESL	threshold ecological screening level
UBC	Under Building Contamination
UCL	upper confidence limit
UL	upper limit (daily intake)
USFWS	U.S. Fish and Wildlife Service
UT	uncertain toxicity
UTL	upper tolerance limit
VOC	volatile organic compound
WAEU	West Area Exposure Unit
WRS	Wilcoxon Rank Sum
WRV	wildlife refuge visitor
WRW	wildlife refuge worker

EXECUTIVE SUMMARY

This report presents the Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA) for the 735-acre Rock Creek Drainage Exposure Unit (EU) (RCEU) at the Rocky Flats Environmental Technology Site (RFETS). The purpose of this report is to assess risks to human health and ecological receptors posed by exposure to contaminants of concern (COCs) and ecological contaminants of potential concern (ECOPCs) remaining at the RCEU after completion of accelerated actions at RFETS.

Results of the COC selection process for the HHRA indicate that no COCs were selected and therefore, no significant human health risks exist at the RCEU from RFETS-related operations. As a result, potential health risks for the wildlife refuge worker (WRW) and wildlife refuge visitor (WRV) are expected to be within the range of background risks. The estimated cancer risks for the WRW and WRV associated with potential exposure to background levels of naturally occurring metals in surface soil/surface sediment are both approximately 2E-06. The estimated noncancer hazard indices associated with potential exposure to background levels of metals in surface soil/surface sediment are approximately 0.3 for the WRW and 0.1 for the WRV.

In addition, no ECOPCs were selected in the ERA. The ECOPC identification process constitutes a screening level risk assessment. Because this process did not identify any ECOPCs in the RCEU, risks to ecological receptors from site-related contaminants are likely to be negligible in this EU.

1.0 INTRODUCTION

This volume of the Comprehensive Risk Assessment (CRA) presents the Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA) for the Rock Creek Drainage Exposure Unit (EU) (RCEU) at the Rocky Flats Environmental Technology Site (RFETS) (Figure 1.1).

The HHRA and ERA methods and selection of receptors are described in detail in the Final CRA Work Plan and Methodology (DOE 2005a), hereafter referred to as the CRA Methodology. A summary of the risk assessment methods, including updates made in consultation with the regulatory agencies, are summarized in Appendix A, Volume 2, Section 2.0 of the Resource Conservation and Recovery Act (RCRA) Facility Investigation-Remedial Investigation (RI)/Corrective Measures Study (CMS)-Feasibility Study (FS) Report (hereafter referred to as the RI/FS Report). The anticipated future land use of RFETS is a wildlife refuge. Consequently, two human receptors, a wildlife refuge worker (WRW) and a wildlife refuge visitor (WRV), are evaluated in this risk assessment consistent with this land use. A variety of representative terrestrial and aquatic receptors are evaluated in the ERA. The assessment of the RCEU includes all terrestrial receptors named in the CRA Methodology including the Preble's meadow jumping mouse (PMJM), a federally listed threatened species present at the RFETS.

1.1 Rock Creek Drainage Exposure Unit Description

This section provides a brief description of the RCEU, including its location at RFETS, historical activities in the area, topography, surface water features, vegetation, and ecological resources. A more detailed description of these features and additional information regarding the geology, hydrology, and soil types at RFETS is included in Section 2.0, Physical Characteristics of the Study Area, of the RI/FS Report.

The Historical Release Report (HRR) and its annual updates provide descriptions of known or suspected releases of hazardous substances that occurred at RFETS (DOE, 2005b). The original HRR (DOE 1992) organized these known or suspected historical sources of contamination as Individual Hazardous Substance Sites (IHSSs), Potential Areas of Concern (PACs), or Under Building Contamination (UBC) sites (hereafter collectively referred to as historical IHSSs). Individual historical IHSSs and groups of historical IHSSs were also designated as Operable Units (OUs). Over the course of cleanup under the 1991 Interagency Agreement (IAG) and the 1996 Rocky Flats Cleanup Agreement (RFCA), the U.S. Department of Energy (DOE) has thoroughly investigated and characterized contamination associated with these historical IHSSs. Historical IHSSs have been dispositioned through appropriate remedial actions or by determining that No Further Accelerated Action (NFAA) is required, pursuant to the applicable IAG and RFCA requirements. Some OUs have also been dispositioned in accordance with an OU-specific Corrective Action Decision/Record of Decision (CAD/ROD).

A more detailed description of the regulatory agreements and the investigation and cleanup history under these agreements is contained in Section 1.0 of the RI/FS Report. Section 1.4.3 of the RI/FS Report describes the accelerated action process, while the disposition of all historical IHSSs at RFETs is summarized in Table 1.4 of the RI/FS Report. The 2005 Annual Update to the HRR (DOE 2005b) provides a description of the potential contaminant releases for each IHSS and any interim response to the releases; identification of potential contaminants based on process knowledge and site data; data collection activities; accelerated action activities (if any); and the basis for recommending NFAA.

The RCEU is located within the Buffer Zone (BZ) OU, northwest of the Industrial Area (IA) that was used for RFETS operations (Figure 1.1). There are no known sources of groundwater or soil contamination within this EU based on the 2005 Annual Update to the HRR (DOE 2005b). No historical IHSSs or PACs are designated in the RCEU (Figure 1.2).

1.1.1 Exposure Unit Characteristics and Location

The 735-acre RCEU is located in the northern and western portions of RFETS (Figure 1.1) and contains several distinguishing features:

- The RCEU is located within the BZ OU and outside of areas that were used historically for operation of RFETS;
- The RCEU is located generally upwind and hydraulically cross-gradient of the Industrial Area (IA); and
- The RCEU is a functionally distinct exposure area. It encompasses much of the Rock Creek drainage area and contains relatively abundant vegetation, water, and wetland habitat.

The RCEU is bounded by the West Area EU (WAEU) to the west and the Inter-Drainage EU (IDEU) to the south and east. The RCEU adjoins the DOE National Wind Technology Center (NWTC) to the northwest and State Highway 128 to the north.

1.1.2 Topography and Surface Water Hydrology

The RCEU encompasses the Rock Creek drainage basin. The basin consists of an alluvial terrace that slopes gently to the northeast and is dissected by Rock Creek and its tributaries, which flow generally from southwest to northeast. The principal surface features in the RCEU include Short Ear Branch, Plum Branch, Mahonia Branch, Snowberry Branch, Lobelia Branch, Grape Draw, and Gentian Draw (Figure 1.2). Two ponds are visible along the main stem of Rock Creek. The westernmost of the two ponds, located at the southern end of the RCEU, is designated Lindsay 2. The other is Lindsay 1. An abandoned ranch house and barn are present directly west of Lindsay 1. The ponds and ranch buildings predate the RFETS.

The drainages and gravel roads that cross the central portion of the RCEU are visible on a July 2005 aerial photograph (Figure 1.3). The roads are used for site security patrols and environmental monitoring activities.

1.1.3 Flora and Fauna

Vegetation in the RCEU is predominantly grassland consisting chiefly of mesic mixed grasslands and xeric tallgrass prairie (Figure 1.4), but most of the plant communities found at RFETS are also present within the Rock Creek drainage. In addition to those mentioned above, these plant communities include tall upland shrubland and seep-fed wetlands on hillsides, with riparian woodlands and wetlands on the valley floor. Other shrublands and Ponderosa pine (*Pinus ponderosa*) woodlands also exist in the western portion of the EU. More information on the plant communities found in Rock Creek is provided in Section 2.0 of the RI/FS Report and also in the Rocky Flats National Wildlife Refuge Final Comprehensive Conservation Plan and Environmental Impact Statement (EIS) (USFWS 2004).

Land within the RCEU was heavily grazed during past land use. However, since the purchase of land by DOE, grazing has not occurred in decades within RCEU and plant communities have nearly returned to their pre-grazed conditions. These plant communities are in near-pristine condition and comprise important natural heritage areas. The Colorado Natural Heritage Program (CNHP) concluded that Rock Creek contains plant communities and wildlife species important to the protection of Colorado's natural diversity (CNHP 1994). CNHP classifies the xeric tallgrass prairie plant community as very rare. Portions of this plant community in the Rock Creek drainage, along with other areas within RFETS and surrounding lands, comprise the largest remnants of xeric tallgrass prairie in Colorado.

Seeps commonly occur along the edge of the pediment in the RCEU, creating ideal conditions for seep-fed wetlands and tall upland shrub communities. These seep-fed wetlands, along with the Antelope Springs wetland complexes in Woman Creek, are significant because they are large, contiguous wetlands and support the most complex plant associations on RFETS (PTI 1997). Tall upland shrubland communities commonly occur just above seeps and wetlands, and the RCEU contains the majority of tall upland shrubland acreage within RFETS. Tall upland shrublands contain the preponderance of plant species found on the site. CNHP identified the tall upland shrubland associations as potentially unique plant communities that may not occur elsewhere. Riparian woodlands, classified by CNHP as Great Plains riparian woodlands and shrublands, are rare and declining plant communities throughout the Great Plains. The RCEU contains unique and important plant communities and supports healthy and vibrant ecosystems.

The RCEU contains three plant species recognized by CNHP as rare or imperiled. They are the carrionflower greenbriar (*Smilax herbacea*), mountain-loving sedge (*Carex oreocharis*), and dwarf indigo (*Amorpha nana*) (K-H 2002a). The carrionflower grows in moist areas beneath the canopy of chokecherry (*Prunus virginana*) and hawthorne (*Crataegus erythropoda*). The mountain-loving sedge grows in dry grasslands and prefers

locations off the edge of the pediment on north-facing slopes. The shrub, dwarf indigo, occurs in the RCEU near the top of the pediment at the edge of the xeric tallgrass prairie.

Numerous animal species have been observed at RFETS and most of these species are expected to be present in the RCEU. Common large and medium-sized mammals likely to live in or frequent the RCEU include the mule deer (*Odocoileus hemionus*), coyote (*Canis latrans*), raccoon (*Procyon lotor*), and desert cottontail (*Sylvilagus audubonii*). The most common reptile observed at RFETS is the western prairie rattlesnake (*Crotalis viridus*), and the most common amphibian is the boreal chorus frog (*Pseudacris tryseriatus*). Common birds include the red-winged blackbird (*Agelaius phoeniceus*), song sparrow (*Melospiza melodia*), meadow lark (*Sturnella neglecta*), and vesper sparrow (*Pooecetes gramineus*). The most common small mammal species include the deer mouse (*Peromyscus maniculatus*), prairie vole (*Microtus ochrogaster*), meadow vole (*Microtus pennsylvanicus*), and different species of harvest mice (*Reithrodontomys sp.*).

More information on the plant communities and animal species that exist within RFETS is provided in Section 2.0 of the RI/FS Report.

1.1.4 Preble's Meadow Jumping Mouse Habitat Within Rock Creek Drainage Exposure Unit

The RCEU supports habitat for the federally protected PMJM (*Zapus hudsonius preblei*) (Figure 1.5), and PMJM have been captured within the RCEU for more than a decade (Ebasco 1992; K-H 1997, 1999, 2002). The RCEU supports approximately 70 (±7) individuals in the middle and lower portions of the EU (K-H 1999). The preferred habitat for the PMJM is the riparian corridors bordering streams, ponds, and wetlands. Although habitat is found throughout the RCEU, few PMJM have been found in the upper portion of the RCEU, and PMJM observed in the lower portion of the RCEU do not travel upstream to the middle portion, suggesting varying habitat quality or habitat discontinuity.

Sitewide PMJM habitat patches were identified in an effort to characterize habitat discontinuity and provide indications of varying habitat quality. Figure 1.5 presents PMJM patches within the RCEU. These patches aid in the evaluation of surface soil within PMJM habitat, giving a spatial understanding of areas that may be used by individual PMJM or subpopulations of PMJM. More detail on the methodology of creating sitewide PMJM habitat patches can be found in Appendix A, Volume 2, Section 3.2 of the RI/FS Report.

PMJM habitat within the RCEU was divided into 10 habitat patches, each containing habitat capable of supporting at least several PMJM individuals. The patches vary in size and shape dependent on their location within the Rock Creek drainage and the discontinuity or habitat quality of surrounding patches. The following is a brief discussion of the 10 patches within the RCEU and the reasons why they are considered distinct:

- Patch #1 – This patch contains habitat within the upper reach of Rock Creek, including the Mahonia and Plum Branches. The vegetation is dominated by tall upland shrubs, and the presence of narrow creek channels with steep rocky banks. Although all the habitat components are present, the narrow channels and steep rocky banks are of lower-quality habitat compared to areas downstream. Patch #1 also includes a small section of habitat that extends into the WAEU.

- Patch #2 – This is the largest patch located within upper Rock Creek where several of the Rock Creek branches come together. Large expanses of seep-fed wetlands are found here along with riparian shrublands and tall upland shrubs. This patch contains some of the highest-quality PMJM habitat on RFETS and supports a number of PMJM (K-H 1999).

- Patch #3A and #3B – This patch is a combination of habitat along a creek corridor (#3A) and an adjacent seep area (#3B). These areas can be considered one unit based on observations of PMJM that used the seep area along with the creek corridor (K-H 1999).

- Patch #4 – This patch is within the lower Rock Creek habitat and is composed of riparian shrubland and woodlands with adjacent upland shrubs such as snowberry and wild plum. Immediately upstream of this patch is a scoured stream reach with little understory vegetation and exposed cobble lining the channel and banks. This area creates the western boundary of this patch. On the downstream side of the patch is a culvert under State Highway 128, which creates the northern boundary. No PMJM inhabiting this patch have ever been observed using or migrating to upstream patches. Conversely, no PMJM inhabiting upstream patches have been observed migrating into this patch.

- Patch #5 – This area contains seep-fed wetlands, tall upland shrubs, mesic grasslands, and riparian shrublands (similar to Patch #2). It represents high-quality habitat and supports a number of PMJM. Individual mice captured and tracked in this patch did not appear to venture into other patches (K-H 1999), preferring to stay in this area using the main channel of Rock Creek and Lobilia Branch (branch extending southwest). This patch also includes a small portion of habitat that extends into the IDEU.

- Patch #6 – This patch surrounds a specific seep area. Surface water from the seep does not connect to Rock Creek, but infiltrates to groundwater and isolates this patch from habitat along the main channel. A break in tall upland shrub vegetation separates this patch from Patch #5.

- Patch #7 – Similar to Patch #6, this patch surrounds two seeps that support tall upland shrubs and short upland shrubs including snowberry (*Symphoricarpos occidentalis*) and sumac (*Rhus aromatica*). The habitat of this patch is of lower quality based on drier conditions and its isolated location.

- Patch #8 – Similar to Patch #1, this patch is located in the upper reaches of Rock Creek. Although it is supported by seeps, it also has a wider creek floodplain and lacks the rocky banks found in branches to the south. Vegetation consists of riparian and tall upland shrubs over a lush understory of grasses and forbs. Because it is in the upper reaches of one branch of Rock Creek, the habitat is drier than downstream areas and, therefore, is of lower quality especially in late summer.

- Patch #32 – This patch is in the upper reaches of Lindsay Branch. It contains an ephemeral pond that is usually dry, with marshlands below the pond and thick grasses adjacent to the marshlands. Shrubs and trees are present but not to the extent of the higher-quality habitat areas found downstream. Ponderosa pine woodlands border the patch to the south.

- Patch #33 – This patch contains tall upland shrublands above Lindsay Branch. From east to west along the patch, the vegetation gets drier although it still supports shrubs. Short upland shrubs along Lindsay Branch create habitat within the western third of the patch. A break in tall upland shrub vegetation separates this patch from Patch #2.

1.1.5 Data Description

Data have been collected at RFETS under regulatory agency-approved Work Plans, Sampling and Analysis Plans (SAPs), and Quality Assurance Project Plans (QAPjPs) to meet data quality objectives (DQOs) and appropriate U.S. Environmental Protection Agency (EPA) and Colorado Department of Public Health and Environment (CDPHE) guidance. Surface soil/surface sediment, subsurface soil/subsurface sediment, surface water, and groundwater samples were collected from the RCEU. Surface soil/surface sediment, subsurface soil/subsurface sediment, surface soil, and subsurface soil are the only media evaluated in the HHRA and ERA (Table 1.1). The sampling locations for these media are shown on Figures 1.6 and 1.7, and data summaries for detected analytes in each medium are provided in Tables 1.2 through 1.6. Potential contaminants of concern (PCOCs) and ecological contaminants of interest (ECOIs) that were analyzed for but not detected or detected in less than 5 percent of RCEU samples are presented in Attachment 1. Detection limits are compared to preliminary remediation goals (PRGs) and ecological screening levels (ESLs), and discussed in Attachment 1 (Tables A1.1 through A1.4).

In accordance with the CRA Methodology, only data from June 1991 to the present are used in the CRA because these data meet the approved analytical quality assurance/quality control (QA/QC) requirements. Additionally, only data for subsurface soil and subsurface sediment samples with a starting depth less than or equal to 8 feet below ground surface (bgs) are used in the CRA. Subsurface soil and subsurface sediment data are limited to this depth because it is not anticipated that the WRW or burrowing animals will dig to deeper depths. A detailed description of data storage and processing methods is provided in Appendix A, Volume 2 of the RI/FS Report.

The CRA analytical data set for the RCEU is provided on a compact disc (CD) presented in Attachment 4 that includes the data used in the CRA as well as data not considered useable. Additional criteria for exclusion of data from use in the CRA are presented in Appendix A, Volume 2 of the RI/FS Report.

The sampling data used for the RCEU HHRA and ERA are as follows:

- Combined surface soil/surface sediment data (HHRA);
- Combined subsurface soil/subsurface sediment data (HHRA);
- Surface soil data (ERA); and,
- Subsurface soil data (ERA).

These data for these media are briefly described below.

Surface water and sediment are assessed for ecological receptors on an aquatic exposure unit (AEU) basis in Appendix A, Volume 15 of the RI/FS Report. An assessment of the surface water, groundwater-to-surface water, and volatilization pathways for human health are presented in Appendix A, Volume 2 of the RI/FS Report.

Surface Soil/Surface Sediment

The combined surface soil/surface sediment data set for RCEU consists of up to 64 samples for various analyte groups (Table 1.1). The surface soil/surface sediment data set includes data from six shallow sediment sampling locations shown on Figure 1.6. The sediment samples were collected from depths less than 0.5 feet bgs was from the sediment surface. For the grid sampling, five individual surface soil samples were collected and composited from each 30-acre cell, one from each quadrant and one in the center, as described in the CRA SAP Addendum 04-01 (DOE 2004). The samples were collected from 1991 to 1993 and in 2004, and were analyzed for inorganics, organics, and radionuclides. In the combined surface soil/surface sediment data set, data exist for 51 inorganic, 32 organic, and 64 radionuclide samples (Table 1.1).

The data summary for detected analytes in surface soil/surface sediment for the RCEU is presented in Table 1.2. Detected analytes included representatives from the inorganic, organic, and radionuclide analyte groups. A summary of analytes that were either not detected in or detected in less than 5 percent of in surface soil/surface sediment samples is presented and discussed in Attachment 1.

Subsurface Soil/Subsurface Sediment

The combined surface soil/surface sediment data set for RCEU consists of up to 15 samples for various analyte groups (Table 1.1). Subsurface sediment samples (that is, sediment samples with a starting depth of less than or equal to 8 feet bgs and an ending depth greater than 0.5 feet bgs) were collected from three locations as shown on Figure 1.7. The combined subsurface soil/subsurface sediment data set contains analyses for 11 inorganic, 15 organic, and 11 radionuclide samples (Table 1.1).

The data summary for subsurface soil/subsurface sediment in the RCEU is presented in Table 1.3. Detected analytes included representatives from the inorganic, organic, and radionuclide analyte groups. A summary of analytes that were either not detected in or detected in less than 5 percent of subsurface soil/subsurface sediment samples is presented and discussed in Attachment 1.

Surface Soil

The surface soil data set for RCEU consists of up to 50 samples for various analyte groups (Table 1.1). The surface soil samples were collected in the RCEU in February 1992, March 1993, and March 2004 from the locations shown on Figure 1.6. The samples collected in 2004 were located on a 30-acre grid, as described in CRA SAP Addendum #04-01 (DOE 2004). For the grid sampling, five individual samples were collected from each 30-acre cell, one from each quadrant and one in the center, as described in the Addendum (DOE 2004). Surface soil sampling location numbers with a prefix starting with A, B, or C on Figure 1.6 represent the 30-acre grid samples. In the surface soil data set, data exist for 36 inorganic, 17 organic, and 50 radionuclide samples, and for PMJM surface soil data set, data exist for 19 inorganic, seven organic, and 29 radionuclide samples (Table 1.1).

The data summary for detected analytes in RCEU surface soil is presented in Table 1.4, while the data summary for the detected analytes for those samples within designated PMJM habitat is presented in Table 1.5. Radionuclides, organics, and inorganics were all detected in RCEU surface soil samples. A summary of analytes that were either not detected in or detected in less than 5 percent of surface soil samples in the RCEU is presented and discussed in Attachment 1.

Subsurface Soil

The subsurface soil data set for the RCEU consists of up to 12 samples for various analyte groups (Table 1.1). Samples were collected in 1991 and 1992 from four locations in the RCEU (Figure 1.7). Subsurface soil samples to be used in the CRA are defined in the CRA Methodology as soil samples with a starting depth less than or equal to 8 feet bgs and an ending depth greater than 0.5 feet bgs.

The data summary for detected analytes in subsurface soil for the RCEU is presented in Table 1.6. Subsurface soil samples were analyzed for inorganics (eight samples), organics (12 samples), and radionuclides (eight samples), and representatives from all three analyte groups were detected. A summary of analytes that were either not detected in or detected in less than 5 percent of subsurface soil samples is presented and discussed in Attachment 1.

1.2 Data Adequacy Assessment

A data adequacy assessment was performed to determine whether the available data set discussed in the previous section is adequate for risk assessment purposes. The data adequacy assessment rules are presented in the CRA Methodology, and a detailed data adequacy assessment for the data used in the CRA is presented in Appendix A, Volume 2

of the RI/FS Report. The adequacy of the data was assessed by examining the number of available samples for each analyte group in each medium for use in the CRA, the spatial and temporal representativeness of the data, as well as information on potential historical sources of contamination, migration pathways, and the concentration levels in the media. The assessment concludes that the data are adequate for the purposes of the CRA.

1.3 Data Quality Assessment

A Data Quality Assessment (DQA) of the RCEU data was conducted to determine whether the data were of sufficient quality for risk assessment use. The DQA is presented in Attachment 2, and an evaluation of the entire RFETS data set is presented in Appendix A, Volume 2 of the RI/FS Report. The quality of the laboratory results were evaluated for compliance with the CRA Methodology DQOs through an overall review of precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters. This review concluded that the data are of sufficient quality for use in the CRA and the CRA DQOs have been met.

2.0 SELECTION OF HUMAN HEALTH CONTAMINANTS OF CONCERN

The human health contaminant of concern (COC) screening process is described in Section 4.4 of the CRA Methodology and summarized in Appendix A, Volume 2 of the RI/FS Report (Section 2.2).

The human health COC selection process was conducted for surface soil/surface sediment and subsurface soil/subsurface sediment in the RCEU. Results of the COC selection process are summarized below.

2.1 Contaminant of Concern Selection for Surface Soil/Surface Sediment

Detected PCOCs in surface soil/surface sediment samples (Table 1.2) are screened in accordance with the CRA Methodology to identify the COCs.

2.1.1 Surface Soil/Surface Sediment Cation/Anion and Essential Nutrient Screen

The major cations and anions that do not have toxicological factors are eliminated from assessments in surface soil/surface sediment in accordance with the CRA Methodology.

The essential nutrient screen for analytes detected in surface soil/surface sediment is presented in Table 2.1. The screen includes PCOCs that are essential for human health and do not have toxicity values. The PRG screen in Section 2.1.2 includes essential nutrients for which toxicity criteria are available. Table 2.1 shows the maximum detected concentrations (MDCs) for essential nutrients, daily intake estimates based on the MDCs, and dietary reference intakes (DRIs). The DRIs are identified in the table as recommended daily allowances (RDAs), recommended daily intakes (RDIs), adequate intakes (AIs), and upper limit daily intakes (ULs). The estimated daily maximum intakes

based on the nutrients' MDCs and a surface soil/surface sediment ingestion rate of 100 milligrams per day (mg/day)are less than the DRIs. Therefore, these PCOCs were not further evaluated as COCs for surface soil/surface sediment.

2.1.2 Surface Soil/Surface Sediment Preliminary Remediation Goals Screen

Table 2.2 compares MDCs and upper confidence limits (UCLs) to the WRW PRGs for each PCOC. If the MDC and the UCL are greater than the PRG, the PCOC is retained for further screening; otherwise, it is not further evaluated. Arsenic, manganese, cesium-134, cesium-137, and radium-228 in surface soil/surface sediment had MDCs and UCLs that exceeded the PRGs and were retained as PCOCs.

PRGs were not available for several PCOCs in surface soil/surface sediment. Analytes without PRGs are listed on Table 2.2 and their effect on the conclusions of the risk assessment results is discussed in the uncertainty section (Section 6.0).

2.1.3 Surface Soil/Surface Sediment Detection Frequency Screen

Arsenic and manganese were detected in more than 5 percent of surface soil/surface sediment samples and, therefore, were retained for further evaluation in the COC screen (Table 1.2). A detection frequency screen was not performed for cesium-134, cesium-137, and radium-228 in surface soil/surface sediment because all reported values for radionuclides are considered detects.

2.1.4 Surface Soil/Surface Sediment Background Analysis

Results of the background statistical comparison for arsenic, manganese, cesium-134, cesium-137, and radium-228 are presented in Table 2.3 and discussed in Attachment 3. Box plots for these constituents (both RCEU and background) are provided in Attachment 3. Arsenic, manganese, cesium-137, and radium-228 were statistically greater than background at the 0.1 significance level, and are evaluated further in the professional judgment section.

2.1.5 Surface Soil/Surface Sediment Professional Judgment Evaluation

Based on the weight of available evidence evaluated by professional judgment, PCOCs will either be included for further evaluation as COCs or excluded as COCs. The professional judgment evaluation takes into account process knowledge, spatial trends, and pattern recognition. As discussed in Section 1.2 and Attachment 2, the sample results are adequate for use in the professional judgment because they are of sufficient quality for use in the CRA.

Based on the weight of evidence described in Attachment 3, arsenic, manganese, cesium-137, and radium-228 in surface soil/surface sediment in the RCEU are not considered COCs and are not further evaluated quantitatively. There is no identified source or pattern of release in the RCEU and the slightly elevated median values of the RCEU data for these PCOCs are most likely due to natural variation. The weight of evidence presented in Attachment 3, Section 4.0 supports the conclusion that concentrations of arsenic and

manganese, and activities of cesium-137 and radium-228 are naturally occurring and not due to site activities.

2.2 Contaminant of Concern Selection for Subsurface Soil/Subsurface Sediment

Detected PCOCs in subsurface soil/subsurface sediment samples (Table 1.3) are screened in accordance with the CRA Methodology to identify the COCs.

2.2.1 Subsurface Soil/Subsurface Sediment Cation/Anion and Essential Nutrient Screen

The major cations and anions that do not have toxicological criteria are eliminated from assessments in subsurface soil/subsurface sediment in accordance with the CRA Methodology.

Essential nutrients without toxicity criteria that were detected in subsurface soil/subsurface sediment in the RCEU are compared to DRIs in Table 2.4. The estimated daily maximum intakes for these PCOCs, based on the nutrient's MDCs and a subsurface soil/subsurface sediment ingestion rate of 100 mg/day, are less than the DRIs. Therefore, these PCOCs were not further evaluated as COCs for subsurface soil/subsurface sediment.

2.2.2 Subsurface Soil/Subsurface Sediment Preliminary Remediation Goal Screen

The PRG screen for detected analytes in subsurface soil/subsurface sediment is presented in Table 2.5. The MDCs for all PCOCs were less than the PRGs. Therefore, no analytes detected in subsurface soil/subsurface sediment were retained beyond the PRG screen.

PRGs were not available for several PCOCs in subsurface soil/subsurface sediment. Analytes without PRGs are listed on Table 2.5 and their effect on the conclusions of the risk assessment results is discussed in the uncertainty section (Section 6.0).

2.2.3 Subsurface Soil/Subsurface Sediment Detection Frequency Screen

The detection frequency screen was not performed for subsurface soil/subsurface sediment because there are no PCOCs with concentrations greater than the PRGs.

2.2.4 Subsurface Soil/Subsurface Sediment Background Analysis

The background analysis was not performed for subsurface soil/subsurface sediment because there are no PCOCs with concentrations greater than the PRGs.

2.2.5 Subsurface Soil/Subsurface Sediment Professional Judgment Evaluation

The professional judgment step was not performed for subsurface soil/subsurface sediment because there are no PCOCs with concentrations greater than the PRGs.

2.3 Contaminant of Concern Selection Summary

A summary of the results of the COC screening process is presented in Table 2.6. No COCs were selected for any of the media at the RCEU.

3.0 HUMAN HEALTH EXPOSURE ASSESSMENT

The site conceptual model (SCM), presented in Figure 2.1 of the CRA Methodology and discussed in Appendix A, Volume 2 of the RI/FS Report, provides an overview of potential human exposures at RFETS for reasonably anticipated land use. However, all PCOCs were eliminated from further consideration as human health COCs for the RCEU based on comparisons of MDCs and UCLs to PRGs, background comparisons, or professional judgment (see Section 2.0). A quantitative risk characterization is not necessary for the RCEU and, therefore, an exposure assessment was not conducted.

4.0 HUMAN HEALTH TOXICITY CRITERIA

Procedures and assumptions for the toxicity criteria are presented in the CRA Methodology. All PCOCs were eliminated from further consideration as human health COCs for the RCEU based on comparisons of MDCs and UCLs to PRGs, background comparisons, or professional judgment (see Section 2). A quantitative risk characterization is not necessary for the RCEU and, therefore, a toxicity assessment was not conducted.

5.0 HUMAN HEALTH RISK CHARACTERIZATION

Information from the exposure assessment and the toxicity criteria sections is integrated in this section to characterize risk to the WRW and WRV receptors. However, all PCOCs were eliminated from further consideration as human health COCs based on comparisons of MDCs and UCLs to PRGs, background comparisons, or professional judgment (see Section 2.0). Therefore, a quantitative risk characterization was not performed for the RCEU.

6.0 UNCERTAINTIES ASSOCIATED WITH THE HUMAN HEALTH RISK ASSESSMENT

There are various types of uncertainties associated with steps of an HHRA. General uncertainties common to the EUs are discussed in Appendix A, Volume 2 of the RI/FS Report. Uncertainties specific to the EU are described below.

6.1 Uncertainties Associated With the Data

Data adequacy for this CRA is evaluated and discussed in Appendix A, Volume 2 of the RI/FS Report. Although there are some uncertainties associated with the sampling and analyses conducted for surface soil/surface sediment and subsurface soil/subsurface sediment at the RCEU, data are considered adequate for the characterization of risk at the EU. The environmental samples for the RCEU were collected from 1991 through 2004. The CRA sampling and analysis requirements for the BZ (DOE 2004, 2005a) specify that the minimum sampling density requirement for surface soil/surface sediment is one five-sample composite for every 30-acre grid cell. This sampling density is exceeded for most of the RCEU given that there are up to 64 surface soil/surface sediment samples for the entire 735-acre EU. In subsurface soil/subsurface sediment, there are up to 15 samples in the RCEU.

Another source of uncertainty in the data is the relationship of detection limits to the PRGs for analytes eliminated as COCs because they were either not detected or had a low detection frequency (i.e., less than 5 percent). The detection limits were appropriate for the analytical methods used, and this is examined in greater detail in Attachment 1.

6.2 Uncertainties Associated With Screening Values

The COC screening analyses utilized RFETS-specific PRGs based on a WRW scenario. The assumptions used in the development of these values were conservative. For example, it is assumed that a future WRW will consume 100 mg of surface soil/surface sediment for 230 days a year for 18.7 years. In addition, a WRW is assumed to be dermally exposed and to inhale surface soil and surface sediment particles in the air. These assumptions are likely to overestimate actual exposures to surface soil for WRWs in the RCEU because a WRW will not spend 100 percent of his or her time in this area. Exposure to subsurface soil and subsurface sediment is assumed to occur 20 days per year. The WRW PRGs for subsurface soil/subsurface sediment are also expected to conservatively estimate potential exposures because it is unlikely a WRW will excavate extensively in the RCEU.

6.2.1 Uncertainties Associated with Potential Contaminants of Concern without Preliminary Remediation Goals

PCOCs for the RCEU for which PRGs are not available are listed in Table 6.1.

Uncertainties associated with the lack of PRGs for analytes listed in Table 6.1 are considered small. The listed inorganics are not usually included in HHRAs because they are not expected to result in significant human health impacts. Phenanthrene is the only organic without a PRG available and has a low detection frequency and, therefore, is not expected to affect the results of the HHRA. Radionuclide PRGs are available for all detected individual radionuclides. Therefore, the lack of PRGs for gross alpha and gross beta activities is also not expected to affect the results of the HHRA.

6.3 Uncertainties Associated with Eliminating Potential Contaminants of Concern Based on Professional Judgment

Arsenic, manganese, cesium-137, and radium-228 in surface soil/surface sediment were eliminated as COCs based on professional judgment. There is no identified source or pattern of release in the RCEU and the slightly elevated median values of the RCEU data for these PCOCs are most likely due to natural variation. The weight of evidence presented in Attachment 3, Section 4.0 supports the conclusion that concentrations of arsenic, manganese, cesium-137, and radium-228 are naturally occurring and not due to site activities. Uncertainty associated with the elimination of these chemicals as COCs is low.

6.4 Uncertainties Evaluation Summary

Evaluation of the uncertainties associated with the data and the COC screening processes indicates there is reasonable confidence in the conclusions of the RCEU risk characterization.

7.0 IDENTIFICATION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN

The ecological contaminant of potential concern (ECOPC) identification process streamlines the ecological risk characterization for each EU by focusing the assessment on ECOIs that are present in the RCEU. ECOIs are defined as any chemical detected in the RCEU and are assessed for surface soils and subsurface soils. ECOIs for sediments and surface water are assessed in Appendix A, Volume 15 of the RI/FS Report. The ECOPC process is described in the CRA Methodology and additional details are provided in Appendix A, Volume 2 of the RI/FS Report.

The process is based on the site conceptual model (SCM) presented in the CRA Methodology and described in detail in Appendix A, Volume 2 of the RI/FS Report. The SCM presents the pathways of potential exposure from documented historical source areas (IHSSs and PACs) to the receptors of concern. Generally, the most significant exposure pathways for wildlife at the RCEU are the ingestion of plant, invertebrate, or animal tissue that could have accumulated ECOIs from the source areas through direct uptake or dietary routes, as well as the direct ingestion of potentially contaminated media.

The receptors of concern that were selected for assessment are listed in Table 7.1 and discussed in detail in Appendix A, Volume 2 of the RI/FS Report, and include representative birds and mammals in addition to the general plant and terrestrial invertebrate communities. The receptors were selected based on several criteria, including their potential to be found in the various habitats present within the RCEU, their potential to come into contact with ECOIs, and the amount of life history and behavioral information available.

For terrestrial plants and invertebrates, the most significant exposure pathway is direct contact with potentially contaminated soil.

The ECOPC process consists of two separate evaluations, one for the PMJM receptor and one for non-PMJM receptors. The ECOPC identification process for the PMJM is conducted separately from non-PMJM receptors because the PMJM is a federally listed threatened species under the Endangered Species Act (63 FR 26517).

7.1 Data Used in the Ecological Risk Assessment

The following RCEU data are used in the CRA:

- A total of 50 surface soil samples were collected and analyzed for inorganics (36 samples), organics (17 samples), and radionuclides (50 samples) (Table 1.2).
- A total of 12 subsurface soil samples were collected and analyzed for inorganics (eight samples), organics (12 samples), and radionuclides (eight samples) (Table 1.2).

A data summary is provided in Table 1.4 for surface soil, Table 1.5 for surface soil in PMJM habitat, and Table 1.6 for subsurface soil.

Sediment and surface water data for the RCEU also were collected (Section 1.2) and these data are evaluated for the ERA in Appendix A, Volume 15 of the RI/FS Report.

The RCEU has 29 sample locations occurring in PMJM habitat, which is described in greater detail in Section 1.1.5. Sampling locations and PMJM habitat patches within the RCEU are shown on Figure 1.5.

7.2 Identification of Surface Soil Ecological Contaminants of Potential Concern

ECOPCs for surface soil were identified for non-PMJM and PMJM receptors in accordance with the sequence presented in the CRA Methodology.

7.2.1 Comparison with No Observed Adverse Effect Level Ecological Screening Levels

In the first step of the ECOPC identification process, the MDCs of ECOIs in surface soil were compared to receptor-specific no observed adverse effect level (NOAEL) ESLs. NOAEL ESLs for surface soil were developed in the CRA Methodology for three receptor groups: terrestrial vertebrates, terrestrial invertebrates, and terrestrial plants.

Non-PMJM Receptors

The NOAEL ESLs for non-PMJM receptors are compared to MDCs in surface soil in Table 7.1. The results of the NOAEL ESL screening analyses for all receptor types are

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summarized in Table 7.2. Analytes with a "Yes" in any of the "Exceedance" columns in Table 7.2 are evaluated further.

NOAEL ESLs were not available for several ECOI/receptor pairs (Tables 7.1 and 7.2). These ECOI/receptor pairs are discussed as ECOIs with uncertain toxicity in Section 10.0, along with the potential impacts to the risk assessment.

PMJM Receptors

The NOAEL ESLs for PMJM receptors were compared to the MDCs of ECOIs in surface soil collected from PMJM habitat (Table 7.3). The MDCs in surface soil that exceed the NOAEL ESLs are identified in Table 7.3 with a "Yes" under the column heading "EPC>PMJM ESL?"

Analytes for which a PMJM NOAEL ESL is not available are identified with a "N/A" in Table 7.3 under the column heading "PMJM NOAEL ESL." These analytes are discussed in the uncertainty section (Section 10.0) as ECOIs with uncertain toxicity.

7.2.2 Surface Soil Frequency of Detection Evaluation

The ECOPC identification process for non-PMJM receptors involves an evaluation of detection frequency for each ECOI retained after the NOAEL screening step. If the detection frequency is less than 5 percent, population-level risks are considered highly unlikely, and the ECOI is not further evaluated. None of the chemicals detected in surface soil at the RCEU that were retained after the NOAEL ESL screening step had a detection frequency less than 5 percent. Therefore, no ECOIs were excluded based on the detection frequency evaluation for surface soil in the RCEU.

7.2.3 Surface Soil Background Comparisons

The ECOIs retained after the NOAEL ESL screening and the detection frequency evaluation were then compared to site-specific background concentrations where available. The statistical methods used for the background comparison are summarized in Appendix A, Volume 2 of the RI/FS Report.

Non-PMJM Receptors

The results of the background comparisons for the non-PMJM receptors are presented in Table 7.4. The analytes listed as being retained as ECOIs in Table 7.4 are evaluated further using upper-bound EPCs in the following section.

PMJM Receptors

The background comparisons for PMJM receptors are conducted differently than for non-PMJM receptors because of their protected status. The results of this comparison are based on their location within PMJM habitat and are presented in Table 7.5. Appendix A, Volume 2 of the RI/FS Report presents further discussion of the PMJM background analysis. The analytes listed as '"Yes" on Table 7.5 are further evaluated in the following sections.

7.2.4 Upper-Bound Exposure Point Concentration Comparisons to Threshold ESLs

The ECOIs retained after completion of all previous evaluations for non-PMJM receptors were then compared to threshold ESLs (tESLs) using upper-bound exposure point concentrations (EPCs) specific to small and large home-range receptors. The calculation of EPCs is described in Appendix A, Volume 2 of the RI/FS Report.

Statistical concentrations for each ECOI retained for the tESL screen are presented in Table 7.6. The EPC for small home-range receptors is the 95 percent UCL of the 90th percentile (upper tolerance limit [UTL]), or the MDC in the event that the 95th UTL is greater than the MDC. The EPC for large home-range receptors is the UCL, or the MDC in the event that the UCL is greater than the MDC.

Small home-range receptors include terrestrial plants, terrestrial invertebrates, mourning dove, American kestrel, deer mouse, and black-tailed prairie dog. These receptors are evaluated by comparing the small home-range EPC (UTL) for each ECOI to the limiting (or lowest) small home-range receptor tESL (if available). In the event that tESLs are not available, the limiting NOAEL ESL is used in accordance with the CRA Methodology.

Large home-range receptors, such as coyote and mule deer, are evaluated by comparing the large home-range EPC (UCL) for each ECOI to the limiting large home-range receptor tESL (if available). In the event that tESLs are not available, the limiting NOAEL ESL is used in accordance with the CRA Methodology.

The upper-bound EPC comparison to limiting tESLs for small and large home-range receptors is presented in Table 7.7. Analytes exceeding the limiting tESLs for small home-range receptors are compared to receptor-specific tESLs in Table 7.8, and analytes exceeding limiting tESLs for large home-range receptors are compared to receptor-specific tESLs in Table 7.9.

Chemicals that exceed any tESLs (if available) are assessed in the professional judgment evaluation. Any analyte/receptor pairs that are retained through professional judgment are identified as ECOPCs and are carried forward in the risk characterization.

7.2.5 Surface Soil Professional Judgment Evaluation

Non-PMJM Receptors

Based on the weight-of-evidence, professional judgment described in Attachment 3, aluminum, barium, boron, chromium, lithium, manganese, molybdenum, nickel, tin, vanadium, zinc, bis(2-ethylhexyl)phthalate, and di-n-butylphthalate in surface soil at the RCEU were not considered ECOPCs for non-PMJM receptors and are not further evaluated quantitatively.

PMJM Receptors

Based on the weight-of-evidence, professional judgment described in Attachment 3, chromium, manganese, molybdenum, nickel, tin, and vanadium in surface soil within

PMJM habitat at the RCEU were not considered ECOPCs for PMJM receptors and are not further evaluated quantitatively.

7.2.6 Summary of Surface Soil Ecological Contaminants of Potential Concern

The ECOPC screening process for surface soil is summarized below for non-PMJM receptors and PMJM receptors.

Non-PMJM Receptors

Inorganic, organic, and radionuclide surface soil ECOIs for non-PMJM receptors in the RCEU were eliminated from further consideration as ECOPCs based on one of the following: 1) the MDC of the ECOI was less than the lowest ESL; 2) no ESLs were available (these ECOIs are discussed in Section 10.0); 3) the concentration of the ECOI in RCEU surface soils was not statistically greater than background surface soils; 4) the upper-bound EPC did not exceed the limiting tESL; or 5) the weight-of-evidence, professional judgment evaluation indicated that the ECOI was not a site-related contaminant of potential concern. No chemicals were retained as ECOPCs.

A summary of the ECOPC screening process for non-PMJM receptors is presented in Table 7.10.

PMJM Receptors

ECOIs in surface soil in PMJM habitat located within the RCEU were evaluated in the ECOPC identification process. ECOIs were removed from further evaluation in the ECOPC identification process based on one of the following: 1) the MDC of the ECOI was less than the NOAEL ESL for PMJM; 2) no NOAEL ESLs were available (these ECOIs are discussed in Section 10.0); 3) the ECOI concentrations within the PMJM habitat in RCEU were not statistically greater than those from background surface soils; or 4) the weight-of-evidence, professional judgment evaluation indicated that the ECOI was not a site-related contaminant of potential concern. No chemicals were retained as ECOPCs. The results of the ECOPC identification process for the PMJM are summarized in Table 7.11.

7.3 Identification of Subsurface Soil Ecological Contaminants of Potential Concern

Subsurface soil sampling locations for soil is collected at a starting depth of 0.5 to 8 feet bgs in the RCEU are identified on Figure 1.6. A data summary for subsurface soil less than 8 feet bgs is presented in Table 1.6.

7.3.1 Comparison to No Observed Adverse Effect Level Ecological Screening Levels

The CRA Methodology indicates subsurface soil is evaluated for those ECOIs that have greater concentrations in subsurface soil than in surface soil. As a conservative screening step, subsurface soil is evaluated for all EUs regardless of the presence/absence of a

change in concentrations from surface soil and subsurface soil. The MDCs of ECOIs in subsurface soil were compared to NOAEL ESLs for burrowing receptors (Table 7.12). ECOIs with MDCs greater than the NOAEL ESL for the prairie dog are further evaluated in the ECOPC identification process.

NOAEL ESLs are not available for some analytes, and these are identified as "UT" in Table 7.12. These constituents are considered ECOIs with uncertain toxicity and are discussed in the uncertainty analysis (Section 10.0).

7.3.2 Subsurface Soil Detection Frequency Evaluation

The ECOPC identification process for burrowing receptors involves an evaluation of detection frequency for each ECOI retained after the NOAEL ESL screening step. If the detection frequency is less than 5 percent, population-level risks are considered highly unlikely and the ECOI is not further evaluated. The detection frequencies for chemicals in subsurface soil are presented in Table 1.6. None of the chemicals (specifically arsenic) in subsurface soil at the RCEU that were retained after the NOAEL ESL screening step had a detection frequency of less than 5 percent. Therefore, no ECOIs were eliminated from further evaluation based on low detection frequencies for subsurface soil in the RCEU.

7.3.3 Subsurface Soil Background Comparison

The ECOIs retained after the ESL screening and detection frequency evaluation were compared to site-specific background concentrations where available. The background comparison was conducted in the same manner as that for surface soil non-PMJM receptors using statistical comparisons.

Analyses were conducted to assess whether arsenic in RCEU subsurface soil is statistically greater than arsenic in sitewide background surface soil at the 0.1 level of significance.

The results of the statistical comparisons of the RCEU data to background data indicate that site concentrations of arsenic in RCEU subsurface soil is statistically greater than background concentrations. The results are summarized in Table 7.13. Box plots for this ECOI (background and RCEU) are presented in Attachment 3 and support the results of the Wilcoxon Rank Sum (WRS) statistical comparisons. Arsenic is evaluated further using upper-bound EPCs in the following section.

7.3.4 Upper-Bound Exposure Point Concentration Comparisons to Threshold ESLs

ECOIs retained after all previous evaluations for burrowing receptors are compared to tESLs using upper-bound EPCs specific to small home-range receptors. The calculation of upper-bound EPCs is discussed in the CRA Methodology.

Because only arsenic was retained following the background analysis step, statistical concentrations for arsenic are presented in Table 7.14. The EPC comparison to tESLs for

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burrowing receptors is presented in Table 7.15. The MDC was used as the EPC because the UTL was greater than the MDC. The subsurface soil UTL for arsenic is greater than the tESL for the prairie dog receptor; therefore, it was evaluated further using professional judgment.

7.3.5 Subsurface Soil Professional Judgment

ECOIs with subsurface soil concentrations that exceed NOAEL ESLs, which have been detected in more than 5 percent of samples, that have slightly elevated concentrations compared to the background data, and which exceed tESLs are subject to a professional judgment evaluation. Based on the weight-of-evidence, professional judgment evaluation described in Attachment 3, arsenic in subsurface soil at the RCEU was not considered an ECOPC for the prairie dog receptor.

7.3.6 Summary of Subsurface Soil Ecological Contaminants of Potential Concern

All subsurface soil ECOIs for burrowing receptors in the RCEU were eliminated from further consideration as ECOPCs based on one of the following: 1) the MDC of the ECOI was less than NOAEL ESL for the burrowing receptor; 2) no ESLs were available (these ECOIs are discussed in Section 10.0); 3) the concentration of the ECOI in RCEU subsurface soils was not statistically greater than background subsurface soils; or 4) the upper-bound EPC was less than the tESL. The results of the subsurface soil ECOPC identification process for burrowing receptors are summarized in Table 7.16.

7.4 Summary of Ecological Contaminants of Potential Concern

ECOIs in surface and subsurface soil in the RCEU were evaluated in the ECOPC identification process for non-PMJM receptors, PMJM receptors, and burrowing receptors. No chemicals were identified as ECOPCs for selected non-PMJM receptors (Table 7.10) or for individual PMJM receptors (Table 7.11). No chemicals were identified as ECOPCs for burrowing receptors (Table 7.16). No other ECOIs were retained past the professional judgment step of the ECOPC identification process for any receptor group (non-PMJM receptors, PMJM receptors, or burrowing receptors).

8.0 ECOLOGICAL EXPOSURE ASSESSMENT

The ECOPC identification process did not identify any ECOPCs for either surface or subsurface soil in the RCEU. Therefore, no exposure assessment for the RCEU was performed.

9.0 ECOLOGICAL TOXICITY ASSESSMENT

The ECOPC identification process did not identify any ECOPCs for either surface or subsurface soil in the RCEU. Therefore, no toxicity assessment for the RCEU was performed.

10.0 ECOLOGICAL RISK CHARACTERIZATION

Risk characterization includes risk estimation and risk description. Details of these components are described in the CRA Methodology and in Appendix A, Volume 2 of the RI/FS Report. Predicted risks should be viewed in terms of the potential for the assumptions used in the risk characterization to occur in nature, the uncertainties associated with the assumptions, and of the potential for effects on the population of receptors that could inhabit the RCEU. No ECOPCs were identified for either surface or subsurface soils in the RCEU. The ECOPC identification procedure constitutes a screening level risk assessment. Because the procedure did not identify any ECOPCs risks to ecological receptors from site-related contaminants are likely to be negligible in the RCEU.

10.1 General Uncertainty Analysis

No ECOPCs were identified for any receptor in either surface or subsurface soil in the RCEU. The ECOPC identification procedure constitutes a screening level risk assessment. Because the procedure did not identify any ECOPCs, risks to ecological receptors from site-related contaminants are likely to be negligible in the RCEU.

10.1.1 Uncertainties Associated With Data Adequacy and Quality

Section 1.2 and 1.3 summarize the general data adequacy and data quality for the RCEU, respectively. A more detailed discussion is presented in Attachment 2 and Appendix A, Volume 2 of the RI/FS. The data adequacy assessment indicates that the data are adequate for the CRA. Data of sufficient quality for ERA purposes were collected in surface soil, including PMJM habitat, and subsurface soil.

10.1.2 Uncertainties Associated with the Lack of Toxicity Data for Ecological Contaminant of Interest Detected at the Rock Creek Drainage Exposure Unit

Several ECOIs detected in the RCEU do not have adequate toxicity data for the derivation of ESLs (CRA Methodology). These ECOIs are listed in Tables 7.1, 7.3, and 7.12 with a "UT" designation. Appendix B of the CRA Methodology outlines a detailed search process that was intended to provide high quality toxicological information for a large proportion of the chemicals detected at RFETS. Although the toxicity is uncertain for those ECOIs that do not have ESLs calculated due to a lack of identified toxicity data, the overall effect on the risk assessment is small because the primary chemicals historically used at RFETS have adequate toxicity data for use in the CRA. Therefore,

while the potential for risk from these ECOPCs is uncertain and will tend to underestimate the overall risk calculated, the magnitude of underestimation is likely to be low.

10.1.3 Uncertainties Associated With Eliminating Ecological Contaminants of Interest Based on Professional Judgment

Aluminum (non-PMJM only), barium (non-PMJM only), boron (non-PMJM only), chromium (PMJM and non-PMJM), lithium (non-PMJM only), manganese (PMJM and non-PMJM), molybdenum (PMJM and non-PMJM), nickel (PMJM and non-PMJM), tin (PMJM and non-PMJM), vanadium (PMJM and non-PMJM, zinc (non-PMJM only), bis(2-ethylhexyl)phthalate (non-PMJM only), and di-n-butylphthalate (non-PMJM) were eliminated as ECOIs in surface soil based on professional judgment. In addition, arsenic was eliminated as an ECOI in subsurface soil based on professional judgment. The professional judgment evaluation is intended to identify those ECOIs that have a limited potential for contamination in the RCEU. The weight-of-evidence supports the conclusion that there is no identified source or pattern of release in the RCEU, and the slightly elevated values of the RCEU data for these ECOIs are most likely due to natural variation. The professional judgment evaluation has little effect on the overall risk calculations because the ECOIs eliminated from further consideration are not related to site-activities in the RCEU and have very low potential to be transported from historical sources to the RCEU.

10.1.4 Summary of Significant Sources of Uncertainty

The preceding discussion outlined the significant sources of uncertainty in the CRA process for assessing ecological risk. While some of the sources of uncertainty discussed tend to either underestimate risk or overestimate risk, many result in an unknown effect on the potential risks. However, the CRA process was designed to be of a conservative nature which should be taken into consideration when reviewing the conclusions of the risk assessment.

11.0 SUMMARY AND CONCLUSIONS

A summary of the results of this CRA for human health and ecological receptors in the RCEU is presented below.

11.1 Human Health

In the COC screening analyses, MDCs and UCLs of analytes in RCEU media were compared to PRGs for the WRW receptor. Inorganic and radionuclide analytes with UCLs greater than the PRGs were statistically compared to the background data set. Inorganic and radionuclide analytes that were statistically greater than background at the 0.1 significance level, and organics with UCL concentrations greater than the PRG were carried forward to professional judgment evaluation. Based on the COC selection

process, no COCs were identified for surface soil/surface sediment or subsurface soil/subsurface sediment.

11.2 Ecological Risk

All ECOIs were eliminated from further consideration as ECOPCs based on comparisons of MDCs to NOAEL ESLs, background comparisons, tESL comparisons (non-PMJM receptors only), or professional judgment evaluations. Therefore, a risk characterization was not performed for the RCEU. Therefore, potential risks to ecological receptors in the RCEU are likely to be negligible.

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TABLES

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Table 1.1
Number of Samples Collected in Each Medium by Analyte Suite

Analyte Suite	Surface Soil/Surface Sediment[a]	Subsurface Soil/Subsurface Sediment[a]	Surface Soil[b]	Surface Soil (PM,JM)[b]	Subsurface Soil[b]
Inorganics	51	11	36	19	8
Organics	32	15	17	7	12
Radionuclides	64	11	50	29	8

[a] Used in the HHRA.

[b] Used in the ERA.

Note: The total number of results (samples) for the analytes listed in Tables 1.2 to 1.6 may differ from the number of samples presented in Table 1.1 because not all analyses are necessarily performed for each sample.

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Table 1.2

Summary of Detected Analytes in Surface Soil/Surface Sediment

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration	Standard Deviation
Inorganics (mg/kg)							
Aluminum	3.7 - 50	51	100	2,380	21,800	13,700	4,020
Ammonia	0.3 - 0.3	9	44.4	0.335	4.81	1.53	1.61
Arsenic	0.14 - 3	51	98.0	1.70	15	5.63	2.44
Barium	0.31 - 40	51	100	34.5	470	167	77
Beryllium	0.022 - 5	49	77.6	0.440	2.10	0.758	0.272
Boron	0.52 - 5	20	100	3.90	17	7.01	3.39
Cadmium	0.064 - 5	47	40.4	0.0750	1.80	0.523	0.442
Calcium	3.5 - 1,000	51	100	1,980	61,000	6,660	8,400
Cesium	93.2 - 749	29	37.9	1.70	3	54.6	72.2
Chromium	0.13 - 10	51	98.0	4.20	23.7	14.2	4.29
Cobalt	0.18 - 10	50	98	3.10	24	7.42	3.64
Copper	0.045 - 10	51	98.0	6.60	29.9	13.9	4.54
Iron	1.3 - 20	51	100	2,520	39,000	15,600	5,890
Lead	0.27 - 4.7	51	100	5.90	79.1	30.9	12.2
Lithium	0.066 - 20	51	100	1.80	17.7	10.5	2.94
Magnesium	2 - 1,000	51	100	444	6,380	2,720	982
Manganese	0.17 - 10	51	100	35.8	2,500	378	430
Mercury	0.0051 - 0.62	47	42.6	0.0210	0.0660	0.0544	0.0457
Molybdenum	0.29 - 40	50	42	0.690	9.60	1.58	1.66
Nickel	0.19 - 20	51	96.1	1.40	25	12.2	4.01
Nitrate / Nitrite	0.02 - 5.5	19	84.2	0.705	40	5.95	9.22
Potassium	22 - 1,170	51	100	342	5,310	2,590	932
Selenium	0.21 - 2.4	51	43.1	0.280	3.20	0.603	0.525
Silica	3.1 - 5.5	20	100	640	2,600	1,020	568
Silicon[b]	0 - 100	29	96.6	75.1	2,250	637	644
Silver	0.077 - 10	50	26	0.110	3.40	0.659	0.643
Sodium	8.9 - 1,000	51	47.1	56.9	413	121	72.8
Strontium	0.058 - 400	51	100	9.50	179	42.2	27.4
Thallium	0.14 - 2.8	49	16.3	0.200	0.410	0.369	0.200
Tin	0.83 - 100	49	34.7	1.20	41.9	12.2	13.1
Titanium[b]	0.086 - 0.73	20	100	86	360	180	81.9
Uranium[b]	1.4 - 3.5	20	10	5.10	7.80	1.33	1.81
Vanadium	0.46 - 10	51	100	6.40	57.1	31.7	9.10
Zinc	0.45 - 10	51	98.0	11.3	130	56.8	19.1
Organics (ug/kg)							
1,1,1-Trichloroethane	5 - 13	7	14.3	9	9	5.14	2.19
2-Butanone[b]	10 - 79	9	11.1	190	190	29.9	60.1
4,6-Dinitro-2-methylphenol	390 - 4,500	22	4.55	1,100	1,100	1,660	1,420
4-Methylphenol	130 - 910	25	12	640	1,500	433	385
4-Nitrophenol	600 - 4,500	23	4.35	1,300	1,300	1,530	1,300
Acetone[b]	10 - 79	9	44.4	46	520	119	178
Benzo(a)anthracene	58 - 910	30	3.33	62	62	325	291
Benzo(a)pyrene	94 - 910	29	3.45	130	130	330	294
Benzoic Acid	680 - 4,500	25	44	43	2,000	1,220	1,090
bis(2-ethylhexyl)phthalate	170 - 910	29	34.5	35	350	257	274
Chrysene	65 - 910	30	3.33	74	74	325	290
Di-n-butylphthalate	48 - 2,000	31	16.1	39	250	301	294
Fluoranthene	53 - 910	30	3.33	89	89	325	290
Methylene Chloride[b]	5 - 40	10	10	300	300	41.2	91.3
Pentachlorophenol	270 - 4,500	24	4.17	1,500	1,500	1,640	1,360
Phenanthrene	82 - 910	30	3.33	59	59	324	291
Phenol	82 - 910	24	4.17	120	120	425	410

Table 1.2
Summary of Detected Analytes in Surface Soil/Surface Sediment

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[a]	Standard Deviation[a]
Pyrene	310 - 910	30	3.33	130	130	327	289
Tetrachloroethene[b]	5 - 14	6	16.7	38	38	10.1	13.8
Toluene[b]	5 - 14	6	16.7	39	39	10.3	14.2
Trichloroethene[b]	5 - 14	7	14.3	48	48	10.7	16.5
Xylene[b, c]	5 - 14	6	16.7	14	14	6.08	4.16
Radionuclides (pCi/g)[d]							
Americium-241	0 - 0.192	49	N/A	-0.00738	0.950	0.0483	0.140
Cesium-134	0.071 - 0.33	13	N/A	0.00200	0.260	0.0899	0.0571
Cesium-137	0.03 - 0.5	22	N/A	0.103	2.50	0.891	0.688
Gross Alpha	1.6 - 30	23	N/A	-1.20	62	21.9	15.5
Gross Beta	2.2 - 20	33	N/A	5.58	54	30.2	9.36
Plutonium-239/240	0 - 0.225	64	N/A	-0.00602	7.25	0.179	0.904
Radium-226	0.16 - 1.1	16	N/A	0.750	1.40	1	0.189
Radium-228	0.07 - 2.5	16	N/A	0.810	2.90	1.93	0.611
Strontium-89/90	0.05 - 0.4	18	N/A	-0.0100	1	0.395	0.320
Uranium-233/234	0 - 0.632	51	N/A	0.343	2.20	1.14	0.413
Uranium-235	0 - 0.774	51	N/A	-0.109	0.466	0.0703	0.107
Uranium-238	0 - 0.556	51	N/A	0.417	1.83	1.11	0.314

[a] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

[b] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

[c] The value for total xylene is used.

[d] All radionuclide values are considered detects.

N/A - Not applicable.

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Table 1.3
Summary of Detected Analytes in Subsurface Soil/Subsurface Sediment

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[a]	Standard Deviation[a]
Inorganics (mg/kg)							
Aluminum	5.1 - 40	11	100	4,900	23,700	13,700	6,090
Antimony	0.69 - 12	10	10	8.80	8.80	2.90	2.31
Arsenic	0.68 - 2	11	100	2.50	13.1	6.80	4.06
Barium	0.18 - 40	11	100	49.5	187	92.7	43.4
Beryllium	0.03 - 1	10	100	0.320	1.30	0.871	0.311
Boron	1.8 - 1.9	2	100	3.40	5.80	4.60	1.70
Cadmium[b]	0.066 - 0.072	2	100	0.210	0.500	0.355	0.205
Calcium	12 - 1,000	11	100	1,440	54,300	19,000	17,500
Cesium[b]	200 - 200	9	100	1.50	3.40	2.54	0.644
Chromium	0.07 - 2	11	100	8.90	55.1	20	12.8
Cobalt	0.14 - 10	11	100	2.60	14.3	6.72	3.63
Copper	0.087 - 5	11	91	5.80	380	56.8	114
Iron	1.5 - 20	11	100	7,800	21,400	14,900	4,150
Lead	0.42 - 1	11	100	3.50	45.7	15.2	12.3
Lithium	0.34 - 20	10	100	4	38.2	10.9	9.80
Magnesium	6.8 - 1,000	11	100	1,000	4,090	2,520	885
Manganese	0.18 - 3	11	100	62.1	355	158	95.4
Mercury	0.0064 - 0.1	10	50	0.0130	0.160	0.0586	0.0502
Molybdenum	0.23 - 40	6	17	0.310	0.310	0.753	0.895
Nickel	0.23 - 8	10	100	6.30	33.4	16.3	7.38
Potassium	42 - 1,000	10	100	710	2,630	1,500	543
Selenium	0.84 - 1	11	18	0.300	1.50	0.313	0.416
Silica[b]	1.8 - 1.9	2	100	760	1,300	1,030	382
Silicon[b]	0 - 0	8	88	10.1	583	134	213
Silver[b]	0.085 - 2	7	29	0.890	3	0.765	1.02
Sodium	110 - 1,000	11	45	75.7	120	91.2	80.8
Strontium	0.11 - 40	11	100	12.8	88.1	40.6	22.5
Thallium	0.37 - 2	10	20	0.250	0.380	0.167	0.0906
Tin[b]	0.66 - 40	9	33	23.4	55.9	19.2	20.1
Titanium[b]	0.26 - 0.28	2	100	48	84	66	25.5
Vanadium	0.41 - 10	11	100	12	50.2	33.2	11.7
Zinc	0.58 - 4	11	100	17.2	59.2	31.2	12.7
Organics (ug/kg)							
2-Butanone	10 - 10	13	7.70	20	20	6.77	3.99
Acetone	5 - 10	12	17	10	68	14.4	19.8
Methylene Chloride	5 - 5	13	38	1	7	4.23	3.89
Toluene	5 - 5	12	100	3	70	19.1	19.9
Radionuclides (pCi/g)							
Americium-241	0 - 0.167	5	N/A	9.71E-04	0.0230	0.0100	0.00958
Cesium-137	0.09 - 0.09	1	N/A	0.370	0.370	0.370	N/A
Gross Alpha	0.81 - 3.5	9	N/A	11.4	28.2	16.1	5.18
Gross Beta	2.4 - 4.8	9	N/A	18.5	49.7	26.4	9.80
Plutonium-239/240	0 - 0.168	11	N/A	-0.00155	0.0575	0.0116	0.0162
Strontium-89/90	0.04 - 0.04	1	N/A	0.0940	0.0940	0.0940	N/A
Uranium-233/234	0 - 0.267	9	N/A	0.425	1.47	0.811	0.347
Uranium-235	0 - 0.29	9	N/A	0.0120	0.0697	0.0449	0.0189
Uranium-238	0.021 - 0.159	9	N/A	0.526	1.19	0.895	0.203

[a] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

[b] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

[c] All radionuclide values are considered detects.

N/A - Not applicable.

Table 1.4
Summary of Detected Analytes in Surface Soil

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[a]	Standard Deviation[a]
Inorganics (mg/kg)							
Aluminum	3.7 - 50	36	100	7,420	21,800	14,500	3,380
Ammonia	0.3 - 0.3	9	44.4	0.335	4.81	1.53	1.61
Arsenic	0.8 - 3	36	100	2.20	8.70	6.08	1.50
Barium	0.36 - 40	36	100	110	470	168	73.9
Beryllium	0.022 - 5	36	77.8	0.440	1.10	0.718	0.150
Boron	0.52 - 1.3	17	100	3.90	7.90	5.72	1
Cadmium	0.064 - 5	34	47.1	0.0750	1.80	0.456	0.427
Calcium	3.5 - 1,000	36	100	2,200	13,600	4,700	2,450
Cesium	200 - 500	19	57.9	1.70	3	26.6	29.6
Chromium	0.15 - 10	36	100	9	22	15.4	2.78
Cobalt	0.18 - 10	36	100	4.80	24	7.33	3.22
Copper	0.045 - 10	36	100	7.70	22.2	13.5	3.43
Iron	1.4 - 20	36	100	10,400	24,900	15,400	3,230
Lead	0.27 - 2	36	100	21	51	33.2	7.72
Lithium	0.066 - 20	36	100	6.80	17.7	11.5	2.33
Magnesium	2 - 1,000	36	100	1,440	6,380	2,810	976
Manganese	0.17 - 10	36	100	160	2,220	363	333
Mercury	0.0051 - 0.2	34	50	0.0210	0.0510	0.0376	0.0140
Molybdenum	0.29 - 40	36	50	0.690	2.70	1.25	0.708
Nickel	0.19 - 20	36	97.2	7.80	25	12.5	3.57
Nitrate / Nitrite	0.2 - 0.2	9	100	0.705	4.79	2.26	1.37
Potassium	22 - 1,000	36	100	1,950	5,310	3,010	663
Selenium	0.79 - 2	36	44.4	0.280	1.30	0.490	0.245
Silica	4.3 - 5.5	17	100	640	980	796	105
Silicon[b]	0 - 100	19	94.7	75.1	2,250	796	105
Silver	0.077 - 10	36	27.8	0.110	0.290	0.508	0.410
Sodium	100 - 1,000	36	36.1	56.9	249	101	44
Strontium	0.058 - 40	36	100	16	109	35.8	16.2
Thallium	0.9 - 2	36	16.7	0.280	0.410	0.349	0.140
Tin[b]	0.83 - 100	36	33.3	1.20	41.9	13.7	14
Titanium[b]	0.086 - 0.11	17	100	86	360	188	86.2
Vanadium	0.46 - 10	36	100	21.1	49	33.1	6.84
Zinc	0.45 - 10	36	100	36	130	56.4	16.7
Organics (ug/kg)							
Benzoic Acid	1,600 - 1,600	11	54.5	43	150	471	425
bis(2-ethylhexyl)phthalate	330 - 480	17	23.5	35	140	163	57.7
Di-n-butylphthalate	330 - 480	17	11.8	39	44	175	54.4
Radionuclides (pCi/g)							
Americium-241	0 - 0.192	37	N/A	-0.00738	0.950	0.0613	0.160
Cesium-134	0.071 - 0.1	8	N/A	0.0710	0.100	0.0851	0.0124
Cesium-137	0.07 - 0.27	11	N/A	0.710	2.50	1.43	0.509
Gross Alpha	1.6 - 30	12	N/A	-1.20	44	18.6	11.4
Gross Beta	2.2 - 20	22	N/A	17.5	37.8	30.9	5.51
Plutonium-239/240	0 - 0.225	50	N/A	-0.00602	7.25	0.222	1.02
Radium-226	0.25 - 0.5	9	N/A	0.800	1.10	0.969	0.112
Radium-228	0.5 - 0.9	9	N/A	1.50	2.90	2.24	0.506
Strontium-89/90	0.22 - 0.34	8	N/A	0.0800	1	0.624	0.321
Uranium-233/234	0 - 0.632	39	N/A	0.343	2.17	1.07	0.362
Uranium-235	0 - 0.774	39	N/A	-0.109	0.466	0.0641	0.113
Uranium-238	0 - 0.556	39	N/A	0.417	1.83	1.11	0.311

[a] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

[b] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

[c] All radionuclide values are considered detects.

N/A - Not applicable.

Table 1.5
Summary of Detected Analytes in Surface Soil (PMJM Habitat)

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[a]	Standard Deviation
Inorganics (mg/kg)							
Aluminum	3.8 - 50	19	100	7,420	21,000	14,788	3,709
Ammonia	0.3 - 0.3	3	66.7	0.335	0.472	0.326	0.150
Arsenic	0.8 - 3	19	100	4.80	8.70	6.43	1.23
Barium	0.36 - 40	19	100	95	470	166	85.4
Beryllium	0.023 - 5	19	78.9	0.440	1.10	0.712	0.150
Boron	0.54 - 1.3	11	100	3.90	7.90	5.86	1.03
Cadmium	0.064 - 5	18	27.8	0.210	1	0.333	0.294
Calcium	3.7 - 1,000	19	100	2,260	10,700	4,713	2,208
Cesium	200 - 500	8	50	1.70	3	30.6	30.3
Chromium	0.15 - 10	19	100	9	21.6	15.2	2.93
Cobalt	0.18 - 10	19	100	5	24	7.85	4.20
Copper	0.045 - 10	19	100	9.50	22.2	13.7	3.17
Iron	1.4 - 20	19	100	10,400	24,000	15,189	3,430
Lead	0.27 - 2	19	100	24	50	31.6	7.08
Lithium	0.069 - 20	19	100	6.80	16.1	11.8	2.24
Magnesium	2.1 - 1,000	19	100	1,440	4,780	2,777	868
Manganese	0.17 - 10	19	100	160	2,220	405	447
Mercury	0.0052 - 0.2	18	61.1	0.0150	0.0510	0.0368	0.0140
Molybdenum	0.29 - 40	19	63.2	0.560	2.70	1.26	0.734
Nickel	0.19 - 20	19	94.7	8.20	25	12.8	4.15
Nitrate / Nitrite	0.2 - 0.2	3	100	1.89	4.17	2.78	1.22
Potassium	23 - 1,000	19	100	1,950	5,310	3,044	714
Selenium	0.79 - 2	19	31.6	0.370	1.30	0.465	0.244
Silica	4.3 - 5.5	11	100	640	980	791	107
Silicon[b]	0 - 100	8	100	119	1,600	738	660
[illegible]ver	0.077 - 10	19	42.1	0.110	0.290	0.466	0.404
[illegible]dium	100 - 1,000	19	31.6	73.3	187	103	41.8
Strontium	0.058 - 40	19	100	20	59.1	35.8	11.3
Thallium	0.9 - 2	19	15.8	0.320	0.410	0.389	0.127
Tin[b]	0.84 - 100	19	36.8	1.20	33	10.1	12.3
Titanium[b]	0.087 - 0.11	11	100	86	300	181	74.8
Vanadium	0.46 - 10	19	100	21.1	49	33.5	7.83
Zinc	0.45 - 10	19	100	36	130	57.1	21.2
Organics (ug/kg)							
Benzoic Acid	1,600 - 1,600	6	33.3	73	110	647	436
bis(2-ethylhexyl)phthalate	330 - 350	7	14.3	49	49	171	55.4
Radionuclides (pCi/g)[c]							
Americium-241	0 - 0.192	19	N/A	-0.00738	0.329	0.0402	0.0718
Cesium-134	0.081 - 0.1	4	N/A	0.0810	0.100	0.0950	0.00935
Cesium-137	0.2 - 0.27	4	N/A	0.710	1.50	1.08	0.327
Gross Alpha	1.6 - 30	7	N/A	-1.20	44	21.0	13.6
Gross Beta	2.2 - 20	11	N/A	23	44	32.1	6.15
Plutonium-239/240	0 - 0.225	29	N/A	0.00823	0.334	0.0805	0.0668
Radium-226	0.28 - 0.47	4	N/A	0.850	1.10	1.01	0.120
Radium-228	0.62 - 0.9	4	N/A	1.70	2.90	2.43	0.525
Strontium-89/90	0.22 - 0.3	4	N/A	0.350	0.810	0.563	0.227
Uranium-233/234	0 - 0.584	20	N/A	0.343	2.17	1.03	0.386
Uranium-235	0.01 - 0.592	20	N/A	-0.0787	0.371	0.0715	0.0918
Uranium-238	0 - 0.493	20	N/A	0.569	1.60	1.10	0.309

[a] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

[b] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

[c] All radionuclide values are considered detects.

N/A - Not applicable.

Table 1.6
Summary of Detected Analytes in Subsurface Soil

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[a]	Standard Deviation
Inorganics (mg/kg)							
Aluminum	40 - 40	8	100	8,640	23,700	15,600	5,880
Antimony	12 - 12	8	12.5	8.80	8.80	3.54	2.13
Arsenic	2 - 2	8	100	2.50	13.1	8.08	4.07
Barium	40 - 40	8	100	49.5	187	90.2	44.1
Beryllium	1 - 1	8	100	0.590	1.30	0.958	0.264
Calcium	1,000 - 1,000	8	100	1,440	54,300	24,200	18,000
Cesium[b]	200 - 200	8	100	1.50	3.40	2.50	0.674
Chromium	2 - 2	8	100	11.4	55.1	21.3	14.1
Cobalt	10 - 10	8	100	4	12.8	6.41	2.81
Copper	5 - 5	8	100	6.70	380	74.9	131
Iron	20 - 20	8	100	10,100	21,400	15,800	4,060
Lead	1 - 1	8	100	3.50	45.7	14.5	13.1
Lithium[b]	20 - 20	8	100	5.50	38.2	12.1	10.7
Magnesium	1,000 - 1,000	8	100	1,700	4,090	2,720	860
Manganese	2 - 3	8	100	62.1	355	159	108
Mercury	0.1 - 0.1	8	37.5	0.0900	0.160	0.0669	0.0530
Nickel	8 - 8	8	100	12.5	33.4	18.2	6.89
Potassium	1,000 - 1,000	8	100	1,180	2,630	1,590	529
Selenium[b]	1 - 1	8	12.5	0.300	0.300	0.134	0.0673
Silicon[b]	N/A	8	87.5	10.1	583	134	213
Silver[b]	2 - 2	5	40	0.890	3	1.05	1.11
Sodium	1,000 - 1,000	8	50	75.7	107	63.7	27.8
Strontium[b]	40 - 40	8	100	12.8	88.1	42.5	25
Thallium	2 - 2	8	25	0.250	0.380	0.161	0.101
Tin[b]	40 - 40	7	42.9	23.4	55.9	24.5	19.7
Vanadium	10 - 10	8	100	16.2	50.2	36.6	10.6
Zinc	4 - 4	8	100	17.2	38.2	26.1	7.48
Organics (ug/kg)							
Acetone	5 - 10	11	18.2	10	68	11.9	18.7
Methylene Chloride	5 - 5	12	41.7	1	7	3.29	2.01
Toluene	5 - 5	12	100	3	70	19.1	19.9
Radionuclides (pCi/g)[c]							
Americium-241	0 - 0.008	2	N/A	9.71E-04	0.00355	0.00226	0.00182
Gross Alpha	0.81 - 3.5	8	N/A	11.4	28.2	16.1	5.53
Gross Beta	2.4 - 4.8	8	N/A	18.5	49.7	26.4	10.5
Plutonium-239/240	0 - 0.017	8	N/A	-0.00155	0.0166	0.00545	0.00525
Uranium-233/234	0 - 0.073	6	N/A	0.551	1.47	0.796	0.360
Uranium-235	0 - 0.052	6	N/A	0.0120	0.0697	0.0491	0.0220
Uranium-238	0.021 - 0.052	6	N/A	0.526	1.12	0.882	0.206

[a] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

[b] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

[c] All radionuclide values are considered detects.

N/A - Not applicable.

Table 2.1
Essential Nutrient Screen for Surface Soil/Surface Sediment

Analyte	MDC (mg/kg)	Estimated Maximum Daily Intake[a] (mg/day)	RDA/RDI/AI[b] (mg/day)	UL[b] (mg/day)	Retain for PRG Screen?
Calcium	61,000	6.10	500-1,200	2,500	No
Magnesium	6,380	0.638	80-420	65-110	No
Potassium	5,310	0.531	2,000-3,500	N/A	No
Sodium	413	0.041	500-2,400	N/A	No

[a] Based on the MDC and a 100 mg/day soil ingestion rate for a WRW.

[b] RDA/RDI/AI/UL taken from NAS 2000, 2002.

N/A = Not available.

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Table 2.2
PRG Screen for Surface Soil/Surface Sediment

Analyte	PRG[a]	MDC	MDC Exceeds PRG?	UCL[b]	UCL Exceeds PRG?	Retain for Detection Frequency Screen?
Inorganics (mg/kg)						
Aluminum	24,774	21,800	No	--	--	No
Ammonia	910,997	4.81	No	--	--	No
Arsenic	**2.41**	**15**	**Yes**	**6.20**	**Yes**	**Yes**
Barium	2,872	470	No	--	--	No
Beryllium	100	2.10	No	--	--	No
Boron	9,477	17	No	--	--	No
Cadmium	91.4	1.80	No	--	--	No
Chromium[c]	28.4	23.7	No	--	--	No
Cobalt	122	24	No	--	--	No
Copper	4,443	29.9	No	--	--	No
Iron	33,326	39,000	Yes	17,000	No	No
Lead	1,000	79.1	No	--	--	No
Lithium	2,222	17.7	No	--	--	No
Manganese	**419**	**2,500**	**Yes**	**641**	**Yes**	**Yes**
Mercury	32.9	0.0660	No	--	--	No
Molybdenum	555	9.60	No	--	--	No
Nickel	2,222	25	No	--	--	No
Nitrate / Nitrite[d]	177,739	40	No	--	--	No
Selenium	555	3.20	No	--	--	No
Silica	N/A	2,600	UT	--	--	UT
Silicon	N/A	2,250	UT	--	--	UT
Silver	555	3.40	No	--	--	No
Strontium	66,652	179	No	--	--	No
Thallium	7.78	0.410	No	--	--	No
Tin	66,652	41.9	No	--	--	No
Titanium	169,568	360	No	--	--	No
Uranium	333	7.80	No	--	--	No
Vanadium	111	57.1	No	--	--	No
Zinc	33,326	130	No	--	--	No
Organics (ug/kg)						
1,1,1-Trichloroethane	9.18E+06	9	No	--	--	No
2-Butanone	4.64E+07	190	No	--	--	No
4,6-Dinitro-2-methylphenol	8,014	1,100	No	--	--	No
4-Methylphenol	400,718	1,500	No	--	--	No
4-Nitrophenol	641,148	1,300	No	--	--	No
Acetone	1.00E+08	520	No	--	--	No
Benzo(a)anthracene	3,793	62	No	--	--	No
Benzo(a)pyrene	379	130	No	--	--	No
Benzoic Acid	3.21E+08	2,000	No	--	--	No
Bis(2-ethylhexyl)phthalate	213,750	350	No	--	--	No
Chrysene	379,269	74	No	--	--	No
Di-n-butylphthalate	8.01E+06	250	No	--	--	No
Fluoranthene	2.96E+06	89	No	--	--	No
Methylene Chloride	271,792	300	No	--	--	No
Pentachlorophenol	17,633	1,500	No	--	--	No
Phenol	2.40E+07	120	No	--	--	No
Pyrene	2.22E+06	130	No	--	--	No
Tetrachloroethene	6,705	38	No	--	--	No
Toluene	3.09E+06	39	No	--	--	No
Trichloroethene	1,770	48	No	--	--	No
Xylene[e]	1.06E+06	14	No	--	--	No
Radionuclides (pCi/g)						

Table 2.2
PRG Screen for Surface Soil/Surface Sediment

Analyte	PRG[a]	MDC	MDC Exceeds PRG?	UCL[b]	UCL Exceeds PRG?	Retain for Detection Frequency Screen?
Americium-241	7.69	0.950	No	--	--	No
Cesium-134	**8.00E-02**	**0.260**	**Yes**	**0.247**	**Yes**	**Yes**
Cesium-137	**0.221**	**2.50**	**Yes**	**1.14**	**Yes**	**Yes**
Gross Alpha	N/A	62	UT	--	--	UT
Gross Beta	N/A	54	UT	--	--	UT
Plutonium-239/240	9.80	7.25	No	--	--	No
Radium-226	2.69	1.40	No	--	--	No
Radium-228	**0.111**	**2.90**	**Yes**	**2.20**	**Yes**	**Yes**
Strontium-89/90	13.2	1	No	--	--	No
Uranium-233/234	25.3	2.20	No	--	--	No
Uranium-235	1.05	0.466	No	--	--	No
Uranium-238	29.3	1.83	No	--	--	No

[a] The value shown is equal to the most stringent of the PRGs based on a risk of 1E-06 or an HQ of 0.1.

[b] UCL = 95% upper confidence limit on the mean, unless the MDC < UCL, then the MDC is used as the UCL.

[c] The PRG for chromium (VI) is used in the PRG screen because it is more conservative than the PRG for chromium (III).

[d] The PRG for nitrate is used.

[e] The value for total xylene is used.

N/A - Not available.

UT = Uncertain toxicity; no PRG available (assessed in Section 6).

-- = Screen not performed because analyte was eliminated from further consideration in a previous step.

Bold = Analyte retained for further consideration in the next COC selection step.

Table 2.3

Statistical Distributions and Background Comparisons for Human Health PCOCs[a]

Analyte	Statistical Distribution Testing Results						Background Comparison Test Results		
	Background Data Set			RCEU Data Set					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Retain as PCOC?
Surface Soil/Surface Sediment									
Arsenic	73	GAMMA	91.8	46	NONPARAMETRIC	100	WRS	2.29E-07	Yes
Manganese	73	GAMMA	100	46	NONPARAMETRIC	100	WRS	6.23E-04	Yes
Cesium-134	77	NONPARAMETRIC	N/A	11	NORMAL	N/A	WRS	0.999	No
Cesium-137	105	NONPARAMETRIC	N/A	18	NORMAL	N/A	WRS	0.0239	Yes
Radium-228	40	GAMMA	N/A	14	NORMAL	N/A	WRS	0.0118	Yes

[a] EU data used for background comparisons do not include data from background locations.

N/A = Not applicable; all radionuclide values are considered detect.

Bold = Analyte retained for further consideration in the next COC selection step.

Table 2.4

Essential Nutrient Screen for Subsurface Soil/Subsurface Sediment

Analyte	MDC (mg/kg)	Estimated Maximum Daily Intake[a] (mg/day)	RDA/RDI/AI[b] (mg/day)	UL[b] (mg/day)	Analyte Retained for PRG Screen?
Calcium	54,300	5.43	500-1,200	2,500	No
Magnesium	4,090	0.409	80-420	65-110	No
Potassium	2,630	0.263	2,000-3,500	N/A	No
Sodium	120	0.012	500-2,400	N/A	No

[a] Based on the MDC and a 100 mg/day soil ingestion rate for a WRW.

[b] RDA/RDI/AI/UL taken from NAS 2000, 2002.

N/A - Not Available.

Table 2.5
PRG Screen for Subsurface Soil/Subsurface Sediment

Analyte	PRG[a]	MDC	MDC Exceeds PRG?	UCL[b]	UCL Exceeds PRG?	Retain for Detection Frequency Screen?
Inorganics (mg/kg)						
Aluminum	284,902	23,700	No	--	--	No
Antimony	511	8.80	No	--	--	No
Arsenic	27.7	13.1	No	--	--	No
Barium	33,033	187	No	--	--	No
Beryllium	1,151	1.30	No	--	--	No
Boron	108,980	5.80	No	--	--	No
Cadmium	1,051	0.500	No	--	--	No
Cesium	N/A	3.40	UT	--	--	UT
Chromium[c]	327	28.4	No	--	--	No
Cobalt	1,401	14.3	No	--	--	No
Copper	51,100	380	No	--	--	No
Iron	383,250	21,400	No	--	--	No
Lead	1,000	45.7	No	--	--	No
Lithium	25,550	38.2	No	--	--	No
Manganese	4,815	355	No	--	--	No
Mercury	379	0.160	No	--	--	No
Molybdenum	6,388	0.310	No	--	--	No
Nickel	25,550	33.4	No	--	--	No
Selenium	6,388	1.50	No	--	--	No
Silica	N/A	1,300	UT	--	--	UT
Silicon	N/A	583	UT	--	--	UT
Silver	6,388	3	No	--	--	No
Strontium	766,500	88.1	No	--	--	No
Thallium	89.4	0.380	No	--	--	No
Tin	766,500	55.9	No	--	--	No
Titanium	N/A	84	UT	--	--	UT
Vanadium	1,278	50.2	No	--	--	No
Zinc	383,250	59.2	No	--	--	No
Organics (ug/kg)						
2-Butanone	5.33E+08	20	No	--	--	No
Acetone	1.15E+09	68	No	--	--	No
Methylene Chloride	3.13E+06	7	No	--	--	No
Toluene	3.56E+07	70	No	--	--	No
Radionuclides (pCi/g)						
Americium-241	88.4	0.0230	No	--	--	No
Cesium-137	2.54	0.370	No	--	--	No
Gross Alpha	N/A	28.2	UT	--	--	UT
Gross Beta	N/A	49.7	UT	--	--	UT
Plutonium-239/240	112	0.0575	No	--	--	No
Strontium-89/90	152	0.0940	No	--	--	No
Uranium-233/234	291	1.47	No	--	--	No
Uranium-235	12.1	0.0697	No	--	--	No
Uranium-238	337	1.19	No	--	--	No

[a] The value shown is equal to the most stringent of the PRGs based on a risk of 1E-06 or an HQ of 0.1.

[b] UCL = 95% upper confidence limit on the mean, unless the MDC < UCL, then the MDC is used as the UCL.

[c] The PRG for chromium (VI) is used in the PRG screen because it is more conservative than the PRG for chromium (III).

N/A - Not Available.

UT = Uncertain toxicity; no PRG available (assessed in Section 6).

-- = Screen not performed because analyte was eliminated from further consideration in a previous step.

Table 2.6
Summary of the COC Selection Process

Analyte	MDC Exceeds PRG?	UCL Exceeds PRG?	Detection Frequency >5%?[a]	Exceeds 30X the PRG?	Exceeds Background?	Professional Judgment - Retain?	Retain as COC?
Surface Soil/Surface Sediment							
Arsenic	Yes	Yes	Yes	N/A	Yes	No	No
Manganese	Yes	Yes	Yes	N/A	Yes	No	No
Iron	Yes	No	--	--	--	--	No
Cesium-134	Yes	Yes	Yes	N/A	No	--	No
Cesium-137	Yes	Yes	Yes	N/A	Yes	No	No
Radium-228	Yes	Yes	Yes	N/A	Yes	No	No
Subsurface Soil/Subsurface Sediment							
No analytes in subsurface soil/surface sediment exceeded the PRG.							

[a] All radionuclide values are considered detects.

N/A = Not applicable.

-- = Screen not performed because analyte was eliminated from further consideration in a previous step.

Table 6.1

Detected PCOCs without PRGs in each Medium by Analyte Suite[a]

Analyte	Surface Soil/Surface Sediment	Subsurface Soil/Subsurface Sediment
Inorganics		
Cesium	X	X[b]
Silica	X	X[b]
Silicon	X[b]	X[b]
Organics		
Phenanthrene	X	N/A
Radionuclides		
Gross Alpha	X	X
Gross Beta	X	X

[a] Does not include essential nutrients. Essential nutrients without PRGs were evaluated by comparing estimated intakes to recommended intakes.

[b] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

N/A = Not applicable. Analyte not detected or not analyzed.

X - indicates PRG is unavailable.

Table 7.1

Comparison of MDCs in Surface Soil to NOAEL ESLs for Terrestrial Plants, Invertebrates, and Vertebrates in the RCEU

ECOI / Receptor	MDC	Terrestrial Plants		Terrestrial Invertebrates		Mourning Dove Herbivore		Mourning Dove Insectivore		American Kestrel		Deer Mouse Herbivore		Deer Mouse Insectivore		Prairie Dog		Mule Deer		Coyote Carnivore		Coyote Generalist		Coyote Insectivore		Terrestrial Receptors		Most Sensitive Receptor	Retain for Further Analysis?
		NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	Results	
Inorganics (mg/kg)																													
Aluminum	21,800	50	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Terrestrial Plants	Yes
Ammonia	4.81	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7,320	No	586	No	26,700	No	37,000	No	2,250	No	2,310	No	2,540	No	N/A	N/A	Deer Mouse Insectivore	No
Arsenic	8.70	10	No	60	No	20	No	164	No	1,030	No	2.57	Yes	51.4	No	9.35	No	13	No	709	No	341	No	293	No	N/A	N/A	Deer Mouse Herbivore	Yes
Barium	470	500	No	330	Yes	159	Yes	357	Yes	1,320	No	930	No	4,430	No	3,220	No	4,770	No	24,900	No	19,800	No	18,400	No	N/A	N/A	Mourning Dove Herbivore	Yes
Beryllium	1.10	10	No	40	No	N/A	N/A	N/A	N/A	N/A	N/A	160	No	6.82	No	211	No	896	No	1,070	No	103	No	29.2	No	N/A	N/A	Deer Mouse Insectivore	No
Boron	7.90	0.500	Yes	N/A	N/A	30.3	No	115	No	167	No	62.1	No	422	No	237	No	314	No	929	No	6,070	No	1,820	No	N/A	N/A	Terrestrial Plants	Yes
Cadmium	1.80	32	No	140	No	28.1	No	0.705	Yes	15	No	59.9	No	1.56	Yes	198	No	723	No	1,360	No	51.2	No	9.75	No	N/A	N/A	Mourning Dove Insectivore	Yes
Calcium	13,600	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Cesium	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Chromium[b]	22	1	Yes	0.400	Yes	24.6	No	1.34	Yes	14	Yes	281	No	15.9	Yes	703	No	1,460	No	4,170	No	250	No	68.5	No	N/A	N/A	Terrestrial Invertebrates	Yes
Cobalt	24	13	Yes	N/A	N/A	278	No	87	No	440	No	1,480	No	363	No	2,460	No	7,900	No	3,780	No	2,490	No	1,520	No	N/A	N/A	Terrestrial Plants	Yes
Copper	22.2	100	No	50	No	28.9	No	8.25	Yes	164	No	295	No	605	No	838	No	4,120	No	5,460	No	3,000	No	4,640	No	N/A	N/A	Mourning Dove Insectivore	Yes
Iron	24,900	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Lead	51	110	No	1,700	No	49.9	Yes	12.1	Yes	95.8	No	1,340	No	242	No	1,850	No	9,800	No	8,930	No	3,070	No	1,390	No	N/A	N/A	Mourning Dove Insectivore	Yes
Lithium	17.7	2	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1,880	No	610	No	3,180	No	10,200	No	18,400	No	5,610	No	2,560	No	N/A	N/A	Terrestrial Plants	Yes
Magnesium	6,380	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Manganese	2,220	500	Yes	N/A	N/A	1,030	Yes	2,630	No	9,920	No	486	Yes	4,080	No	1,519	Yes	2,510	No	14,100	No	10,900	No	19,100	No	N/A	N/A	Deer Mouse Herbivore	Yes
Mercury	0.0510	0.300	No	0.100	No	0.197	No	1.00E-04	Yes	1.57	No	0.439	No	0.179	No	3.15	No	7.56	No	8.18	No	8.49	No	37.3	No	N/A	N/A	Mourning Dove Insectivore	Yes
Molybdenum	2.70	2	Yes	N/A	N/A	44.4	No	6.97	No	76.7	No	8.68	No	1.90	Yes	27.1	No	44.3	No	275	No	28.9	No	8.18	No	N/A	N/A	Deer Mouse Insectivore	Yes
Nickel	25	30	No	200	No	44.1	No	1.24	Yes	13.1	Yes	16.4	Yes	0.431	Yes	38.3	No	124	No	90.9	No	6.02	Yes	1.86	Yes	N/A	N/A	Deer Mouse Insectivore	Yes
Nitrate / Nitrite	4.79	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4,480	No	7,650	No	16,200	No	22,700	No	32,900	No	32,200	No	32,900	No	N/A	N/A	Deer Mouse Herbivore	No
Potassium	5,310	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Selenium	1.30	1	Yes	70	No	1.61	No	1	Yes	8.48	No	0.872	Yes	0.754	Yes	2.80	No	3.82	No	32.5	No	12.2	No	5.39	No	N/A	N/A	Deer Mouse Insectivore	Yes
Silver	0.290	2	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Terrestrial Plants	No
Sodium	249	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Strontium	109	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	940	No	13,600	No	3,520	No	4,700	No	584,000	No	145,000	No	57,300	No	N/A	N/A	Deer Mouse Herbivore	No
Thallium	0.410	1	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	180	No	7.24	No	204	No	1,040	No	212	No	81.6	No	30.8	No	N/A	N/A	Terrestrial Plants	No
Tin	41.9	50	No	N/A	N/A	26.1	Yes	2.90	Yes	19	Yes	45	No	3.77	Yes	80.6	No	242	No	70	No	36.1	Yes	16.2	Yes	N/A	N/A	Mourning Dove Insectivore	Yes
Titanium	360	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Vanadium	49	2	Yes	N/A	N/A	503	No	274	No	1,510	No	63.7	No	29.9	Yes	83.5	No	358	No	341	No	164	No	121	No	N/A	N/A	Terrestrial Plants	Yes
Zinc	130	50	Yes	200	No	109	Yes	0.646	Yes	113	Yes	171	No	5.29	Yes	1,170	No	2,770	No	16,500	No	3,890	No	431	No	N/A	N/A	Mourning Dove Insectivore	Yes
Organics (mg/kg)																													
Benzoic acid	150	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Bis(2-ethylhexyl)phthalate	140	N/A	N/A	N/A	N/A	19,500	No	137	Yes	398	No	960,000	No	8,070	No	2.76E+06	No	4.93E+06	No	42,300	No	40,200	No	35,000	No	N/A	N/A	Mourning Dove Insectivore	Yes
Di-n-butylphthalate	44	200,000	No	N/A	N/A	989	No	15.9	Yes	41.5	Yes	1.21E+07	No	281,000	No	4.06E+07	No	6.13E+07	No	1.29E+06	No	1.27E+06	No	1.22E+06	No	N/A	N/A	Mourning Dove Insectivore	Yes
Radionuclides (pCi/g)																													
Americium-241	0.950	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3,890	No	N/A	No
Cesium-137	2.50	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20.8	No	N/A	No
Gross Alpha	44	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Gross Beta	37.81	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Plutonium-239/240	7.25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6,110	No	N/A	No
Radium-226	1.10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	50.6	No	N/A	No
Radium-228	2.90	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	43.9	No	N/A	No
Strontium-89/90	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	22.5	No	N/A	No
Uranium-233/234	2.17	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4,980	No	N/A	No
Uranium-235	0.370	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2,770	No	N/A	No
Uranium-238	1.83	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1,580	No	N/A	No

[a] Radionuclide ESLs are not receptor-specific. They are considered protective of all terrestrial ecological species.

[b] The ESLs for chromium were developed using available toxicity data based on chromium III (birds) and chromium VI (plants, invertebrates, and mammals).

N/A = No ESL was available for that ECOI/receptor pair.

UT = Uncertain toxicity; no ESL available (assessed in Section 10.0).

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.2
Summary of Non-PMJM NOAEL ESL Screening Results for Surface Soil in the RCEU

Analyte	Terrestrial Plant Exceedance?	Terrestrial Invertebrate Exceedance?	Terrestrial Vertebrate Exceedance?
Inorganics			
Aluminum	**Yes**	UT	UT
Ammonia	UT	UT	No
Arsenic	No	No	**Yes**
Barium	No	**Yes**	**Yes**
Beryllium	No	No	No
Boron	**Yes**	UT	No
Cadmium	No	No	**Yes**
Calcium	UT	UT	UT
Cesium	UT	UT	UT
Chromium	**Yes**	**Yes**	**Yes**
Cobalt	**Yes**	UT	No
Copper	No	No	**Yes**
Iron	UT	UT	UT
Lead	No	No	**Yes**
Lithium	**Yes**	UT	No
Magnesium	UT	UT	UT
Manganese	**Yes**	UT	**Yes**
Mercury	No	No	**Yes**
Molybdenum	**Yes**	UT	**Yes**
Nickel	No	No	**Yes**
Nitrate / Nitrite	UT	UT	No
Potassium	UT	UT	UT
Selenium	**Yes**	No	**Yes**
Silver	No	UT	UT
Sodium	UT	UT	UT
Strontium	UT	UT	No
Thallium	No	UT	No
Tin	No	UT	**Yes**
Titanium	UT	UT	UT
Vanadium	**Yes**	UT	**Yes**
Zinc	**Yes**	No	**Yes**
Organics			
Benzoic acid	UT	UT	UT
Bis(2-ethylhexyl)phthalate	UT	UT	**Yes**
Di-n-butylphthalate	No	UT	**Yes**
Radionuclides			
Americium-241	UT	UT	No
Cesium-137	UT	UT	No
Gross Alpha	UT	UT	UT
Gross Beta	UT	UT	UT
Plutonium-239/240	UT	UT	No
Radium-226	UT	UT	No
Radium-228	UT	UT	No
Strontium-89/90	UT	UT	No
Uranium-233/234	UT	UT	No
Uranium-235	UT	UT	No
Uranium-238	UT	UT	No

UT = Uncertain toxicity; no ESL available (assessed in Section 10).

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.3
Comparison of MDCs in Surface Soil with NOAEL ESLs for the PMJM in the RCEU

Analyte	MDC	PMJM NOAEL ESL	EPC > PMJM ESL?
Inorganics (mg/kg)			
Aluminum	21,000	N/A	UT
Ammonia	0.47	673	No
Antimony	0.48	1	No
Arsenic	**8.7**	**2.21**	**Yes**
Barium	470	743	No
Beryllium	1.1	8.16	No
Boron	7.9	52.7	No
Cadmium	1	1.75	No
Calcium	10,700	N/A	UT
Cesium	3	N/A	UT
Chromium[a]	**21.6**	**19.3**	**Yes**
Cobalt	24	340	No
Copper	22.2	95	No
Iron	24,000	N/A	UT
Lead	50	220	No
Lithium	16.1	519	No
Magnesium	4,780	N/A	UT
Manganese	**2,220**	**388**	**Yes**
Mercury	0.05	0.0521	No
Molybdenum	**2.7**	**1.84**	**Yes**
Nickel	**25**	**0.510**	**Yes**
Nitrate / Nitrite	4.17	2,910	No
Potassium	5,310	N/A	UT
Selenium	**1.3**	**0.421**	**Yes**
Silica	980	N/A	UT
Silicon	1,600	N/A	UT
Silver	0.29	N/A	UT
Sodium	187	N/A	UT
Strontium	59.1	833	No
Thallium	0.41	8.64	No
Tin	**33**	**4.22**	**Yes**
Titanium	300	N/A	UT
Vanadium	**49**	**21.6**	**Yes**
Zinc	**130**	**6.41**	**Yes**
Organics (µg/kg)			
Benzoic acid	110	N/A	UT
Bis(2-ethylhexyl)phthalate	49	10,166	No
Radionuclides (pCi/kg)			
Americium-241	0.33	3,890	No
Cesium-134	0.1	N/A	UT
Cesium-137	1.5	20.8	No
Gross alpha	44	N/A	UT
Gross beta	44	N/A	UT
Plutonium-239/240	0.33	6,110	No
Radium-226	1.1	50.6	No
Radium-228	2.90	43.9	No
Strontium-89/90	0.81	22.5	No
Uranium-233/234	2.17	4,980	No
Uranium-235	0.37	2,770	No
Uranium-238	1.6	1,580	No

[a] The ESL for chromium VI is used.

N/A = No ESL Available.

UT = Uncertain toxicity; no ESL available (assessed in Section 10.0).

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.4

Statistical Distribution and Comparison to Background for Surface Soil in the RCEU

Analyte	Statistical Distribution Testing Results						Background Comparison Test Results		
	Background Data Set			RCEU Data Set					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Retain as ECOI?
Inorganics (mg/kg)									
Aluminum	20	NORMAL	100	36	NORMAL	100	t-Test_N	1.08E-05	**Yes**
Arsenic	20	NORMAL	100	36	NORMAL	100	t-Test_N	0.504	No
Barium	20	NORMAL	100	36	NONPARAMETRIC	100	WRS	1.33E-08	**Yes**
Boron	N/A	N/A	N/A	17	NORMAL	100	N/A	N/A	**Yes[a]**
Cadmium	20	NONPARAMETRIC	65	34	GAMMA	47.1	WRS	0.994	No
Chromium	20	NORMAL	100	36	NORMAL	100	t-Test_N	1.04E-06	**Yes**
Cobalt	20	NORMAL	100	36	NONPARAMETRIC	100	WRS	0.854	No
Copper	20	NONPARAMETRIC	100	36	NORMAL	100	WRS	0.369	No
Lead	20	NORMAL	100	36	NORMAL	100	t-Test_N	0.560	No
Lithium	20	NORMAL	100	36	NORMAL	100	t-Test_N	2.27E-08	**Yes**
Manganese	20	NORMAL	100	36	NONPARAMETRIC	100	WRS	0.00100	**Yes**
Mercury	20	NONPARAMETRIC	40	34	NONPARAMETRIC	50	WRS	1	No
Molybdenum	20	NORMAL	0	36	NONPARAMETRIC	50	N/A	N/A	**Yes[a]**
Nickel	20	NORMAL	100	36	GAMMA	97.2	WRS	0.00200	**Yes**
Selenium	20	NONPARAMETRIC	60	36	NONPARAMETRIC	44.4	WRS	0.930	No
Tin	20	NORMAL	0	36	NONPARAMETRIC	33.3	N/A	N/A	**Yes[a]**
Vanadium	20	NORMAL	100	36	NORMAL	100	t-Test_N	0.00500	**Yes**
Zinc	20	NORMAL	100	36	NONPARAMETRIC	100	WRS	0.0970	**Yes**

[a] Statistical comparisons to background cannot be performed. The analyte is retained as an ECOI for further evaluation.

N/A = Not applicable; background data not available or not detected.

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.5
Statistical Distributions and Comparison to Background for Surface Soil in PMJM Habitat in the RCEU

Analyte	Statistical Distribution Testing Results						Background Comparison Test Results		
	Background Data Set			RCEU Data Set			Test	1 - p	Retain as ECOI?
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)			
Inorganics									
Arsenic	20	NORMAL	100	19	NORMAL	100	t-Test N	0.260	No
Chromium	20	NORMAL	100	19	NORMAL	100	t-Test N	5.58E-05	**Yes**
Manganese	20	NORMAL	100	19	NONPARAMETRIC	100	WRS	0.00500	**Yes**
Molybdenum	20	NORMAL	0	19	NONPARAMETRIC	63.2	N/A	N/A	**Yes**[a]
Nickel	20	NORMAL	100	19	GAMMA	94.7	WRS	0.00800	**Yes**
Selenium	20	NONPARAMETRIC	60	19	NONPARAMETRIC	31.6	WRS	0.916	No
Tin	20	NORMAL	0	19	NONPARAMETRIC	36.8	N/A	N/A	**Yes**[a]
Vanadium	20	NORMAL	100	19	NORMAL	100	t-Test N	0.0140	**Yes**
Zinc	20	NORMAL	100	19	NONPARAMETRIC	100	WRS	0.188	No

[a] Statistical comparisons to background cannot be performed. The analyte is retained as an ECOI for further evaluation.

N/A = Not applicable; background data not available or not detected.

Bold = Analyte retained for further consideration in the next ECOPC selection step.

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Table 7.6
Statistical Concentrations in Surface Soil in the RCEU

Analyte	Total Samples	UCL Recommended by ProUCL	Distribution Recommended by ProUCL	Mean Concentration	Median Concentration	75th Percentile	95th Percentile	UCL	UTL	MDC
Inorganics (mg/kg)										
Aluminum	36	95% Student's-t UCL	NORMAL	14,530	14,000	16,775	20,250	15,480	20,350	21,800
Barium	36	95% Student's-t UCL	NONPARAMETRIC	168	139	173	296	189	324	470
Boron	17	95% Student's-t UCL	NORMAL	5.72	5.60	6.20	7.02	6.14	7.72	7.90
Chromium	36	95% Student's-t UCL	NORMAL	15.4	15	17	20.6	16.1	20.2	22
Lithium	36	95% Student's-t UCL	NORMAL	11.5	11.3	13.1	14.7	12.2	15.5	17.7
Manganese	36	95% Student's-t UCL	NONPARAMETRIC	363	300	343	556	457	734	2,220
Molybdenum	36	95% Student's-t UCL	NONPARAMETRIC	1.25	0.880	1.59	2.63	1.45	2.70	2.90
Nickel	36	95% Approximate Gamma UCL	GAMMA	12.5	11.6	14.7	18	13.5	18.7	25
Tin	36	95% Chebyshev (Mean, Sd) UCL	NONPARAMETRIC	13.7	12.2	24.9	37.3	36.9	41.3	41.9
Vanadium	36	95% Student's-t UCL	NORMAL	33.1	31.7	36.3	45.8	35	44.9	49
Zinc	36	95% Student's-t UCL	NONPARAMETRIC	56.4	53.3	59.3	81.1	61.1	90.2	130
Bis(2-ethylhexyl)phthalate	17	95% Chebyshev (Mean, Sd) UCL	NONPARAMETRIC	163	185	190	220	224	240	240
Di-n-butylphthalate	17	95% Chebyshev (Mean, Sd) UCL	NONPARAMETRIC	175	185	195	240	232	240	240

MDC = Maximum detected concentration or in some cases, maximum proxy result.
UCL = 95% upper confidence limit on the mean, unless the MDC < UCL, then the MDC is used as the UCL.
UTL = 95% upper confidence limit on the 90th percentile value, unless the MDC < UCL, then the MDC is uesed as the UTL.

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Table 7.7
Upper-Bound Exposure Point Concentration Comparison to Limiting tESLs in the RCEU Surface Soil

Analyte	Small Home Range Receptors			Large Home Range Receptors		
	EPC (95UTL)	Limiting ESL[a]	EPC>ESL?	EPC (95UCL)	Limiting ESL[b]	EPC>ESL?
Inorganics (mg/kg)						
Aluminum	20,350	50	**Yes**	15,480	N/A	N/A
Barium	324	159	**Yes**	189	4,770	No
Boron	7.70	0.500	**Yes**	6.10	314	No
Chromium[c]	20.2	0.400	**Yes**	16.1	68.5	No
Lithium	16	2	**Yes**	12.2	2,560	No
Manganese	734	486	**Yes**	457	2,510	No
Molybdenum	2.70	1.90	**Yes**	1.50	8.18	No
Nickel	18.7	0.431	**Yes**	13.5	1.86	**Yes**
Tin	41.3	2.90	**Yes**	36.9	16.2	**Yes**
Vanadium	44.9	2	**Yes**	35	121	No
Zinc	90.2	0.646	**Yes**	61.1	431	No
Bis(2-ethylhexyl)phthalate	240	137	**Yes**	224	35,000	No
Di-n-butylphthalate	240	15.9	**Yes**	232	1.22E+06	No

[a]Lowest ESL (threshold if available) for the plant, invertebrate, deer mouse, prairie dog, dove, or kestrel receptors.

[b]Lowest ESL (threshold if available) for the coyote and mule deer receptors.

[c]The ESL for chromium VI is used.

N/A = Not applicable; ESL not available.

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.8

Upper-Bound Exposure Point Concentration Comparison to Receptor-Specific ESLs for Small Home-Range Receptors in the RCEU Surface Soil

Analyte	Small Home Range Receptor UTL	Receptor-Specific ESLs[a]							
		Terrestrial Plant	Terrestrial Invertebrate	American Kestrel	Mourning Dove (herbivore)	Mourning Dove (insectivore)	Deer Mouse (herbivore)	Deer Mouse (insectivore)	Prairie Dog
Inorganics (mg/kg)									
Aluminum	20,350	**50**	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Barium	324	500	330	1,320	**159**	357	930	4,430	3,220
Boron	7.70	**0.500**	N/A	167	30.3	115	62.1	422	237
Chromium	20.2	**1**	**0.400**	**14**	24.6	**1.34**	281	**15.9**	703
Lithium	16	**2**	N/A	N/A	N/A	N/A	1,880	610	3,180
Manganese	734	**500**	N/A	9,920	1,030	2,630	**486**	4,080	1,519
Molybdenum	2.70	**2**	N/A	76.1	44.1	6.97	8.68	**1.90**	27.1
Nickel	18.7	30	200	89.9	320	**7.84**	**16.4**	**0.431**	38.3
Tin	41.3	50	N/A	**19**	**26.1**	**2.90**	45	**3.77**	80.6
Vanadium	44.9	**2**	N/A	1,510	503	274	63.7	**29.9**	83.5
Zinc	90.2	**50**	200	113	109	**0.646**	171	**5.29**	1,170
Bis(2-ethylhexyl)phthalate	240	200,000	N/A	398	19,500	**137**	96,200	8,070	27,600
Di-n-butylphthalate	240	N/A	N/A	**41.5**	989	**15.9**	1.21E+06	281,000	4.06E+06

[a]Lowest ESL (threshold if available) for that receptor.

N/A = Not applicable; ESL not available.

Bold = Receptors of potential concern.

Table 7.9

Upper-Bound Exposure Point Concentration Comparison to Receptor-Specific ESLs for Large Home-Range Receptors in the RCEU Surface Soil

Analyte	Large Home Range Receptor 95th UCL	Receptor-Specific ESLs[a]			
		Mule Deer	Coyote (carnivore)	Coyote (generalist)	Coyote (insectivore)
Inorganics (mg/kg)					
Nickel	13.5	124	91	**6**	**1.9**
Tin	36.9	242	70	**36.1**	**16.2**

[a]Lowest ESL (threshold if available) for that receptor.

Bold = Receptors of potential concern.

Table 7.10
Summary of ECOPC Screening Steps for Surface Soil Non-PMJM Receptors in the RCEU

Analyte	Exceed Any NOAEL ESL?	Detection Frequency >5%?	Exceed Background?[a]	Upper-Bound EPC > Limiting ESL?	Professional Judgment - Retain?	ECOPC?	Receptor(s) of Potential Concern
Inorganics							
Aluminum	Yes	Yes	Yes	Yes	No	No	--
Ammonia	No	--	--	--	--	No	--
Arsenic	Yes	Yes	No	--	--	No	--
Barium	Yes	Yes	Yes	Yes	No	No	--
Beryllium	No	--	--	--	--	No	--
Boron	Yes	Yes	N/A	Yes	No	No	--
Cadmium	Yes	Yes	No	--	--	No	--
Calcium	UT	--	--	--	--	No	--
Cesium	UT	--	--	--	--	No	--
Chromium	Yes	Yes	Yes	Yes	No	No	--
Cobalt	Yes	Yes	No	--	--	No	--
Copper	Yes	Yes	No	--	--	No	--
Iron	UT	--	--	--	--	No	--
Lead	Yes	Yes	No	--	--	No	--
Lithium	Yes	Yes	Yes	Yes	No	No	--
Magnesium	UT	--	--	--	--	No	--
Manganese	Yes	Yes	Yes	Yes	No	No	--
Mercury	Yes	Yes	No	--	--	No	--
Molybdenum	Yes	Yes	N/A	Yes	No	No	--
Nickel	Yes	Yes	Yes	Yes	No	No	--
Nitrate / Nitrite	No	--	--	--	--	No	--
Potassium	UT	--	--	--	--	No	--
Selenium	Yes	Yes	No	--	--	No	--
Silver	No	--	--	--	--	No	--
Sodium	UT	--	--	--	--	No	--
Strontium	No	--	--	--	--	No	--
Thallium	No	--	--	--	--	No	--
Tin	Yes	Yes	N/A	Yes	No	No	--
Titanium	UT	--	--	--	--	No	--
Vanadium	Yes	Yes	Yes	Yes	No	No	--
Zinc	Yes	Yes	Yes	Yes	No	No	--
Organics							
Benzoic acid	UT	--	--	--	--	No	--
Bis(2-ethylhexyl)phthalate	Yes	Yes	N/A	Yes	No	No	--
Di-n-butylphthalate	Yes	Yes	N/A	Yes	No	No	--
Radionuclides							
Americium-241	No	--	--	--	--	No	--
Cesium-137	No	--	--	--	--	No	--
Gross Alpha	UT	--	--	--	--	No	--
Gross Beta	UT	--	--	--	--	No	--
Plutonium-239/240	No	--	--	--	--	No	--
Radium-226	No	--	--	--	--	No	--
Radium-228	No	--	--	--	--	No	--
Strontium-89/90	No	--	--	--	--	No	--
Uranium-233/234	No	--	--	--	--	No	--
Uranium-235	No	--	--	--	--	No	--
Uranium-238	No	--	--	--	--	No	--

[a] Based on results of statistical analysis at the 0.1 level of significance.

-- = Screen not performed because ECOI was eliminated from further consideration in a previous step.

N/A = Not applicable; background not available or not detected.

UT = Uncertain toxicity; no ESL available (assessed in Section 10).

Table 7.11
Summary of ECOPC Screening Steps for Surface Soil PMJM Receptors in the RCEU

Analyte	Exceed PMJM NOAEL ESL?	Exceeds Background?	Professional Judgment - Retain?	ECOPC?
Inorganics				
Aluminum	UT	--	--	No
Ammonia	No	--	--	No
Antimony	No	--	--	No
Arsenic	**Yes**	No	--	No
Barium	No	--	--	No
Beryllium	No	--	--	No
Boron	No	--	--	No
Cadmium	No	--	--	No
Calcium	UT	--	--	No
Cesium	UT	--	--	No
Chromium	Yes	Yes	No	No
Cobalt	No	--	--	No
Copper	No	--	--	No
Iron	UT	--	--	No
Lead	No	--	--	No
Lithium	No	--	--	No
Magnesium	UT	--	--	No
Manganese	Yes	Yes	No	No
Mercury	No	--	--	No
Molybdenum	Yes	N/A	No	No
Nickel	Yes	Yes	No	No
Nitrate / Nitrite	No	--	--	No
Potassium	UT	--	--	No
Selenium	Yes	No	--	No
Silica	UT	--	--	No
Silicon	UT	--	--	No
Silver	UT	--	--	No
Sodium	UT	--	--	No
Strontium	No	--	--	No
Thallium	No	--	--	No
Tin	Yes	N/A	No	No
Titanium	UT	--	--	No
Vanadium	Yes	Yes	No	No
Zinc	Yes	No	--	No
Organics				
Benzoic acid	UT	--	--	No
Bis(2-ethylhexyl)phthalate	No	--	--	No
Radionuclides				
Americium-241	No	--	--	No
Cesium-134	UT	--	--	No
Cesium-137	No	--	--	No
Gross alpha	UT	--	--	No
Gross beta	UT	--	--	No
Plutonium-239/240	No	--	--	No
Radium-226	No	--	--	No
Radium-228	No	--	--	No
Strontium-89/90	No	--	--	No
Uranium-233/234	No	--	--	No
Uranium-235	No	--	--	No
Uranium-238	No	--	--	No

-- = Screen not performed because ECOI was eliminated from further consideration in a previous step.
N/A = Not applicable; background not available or not detected.
UT = Uncertain toxicity; no ESL available (assessed in Section 10).

Table 7.12

Comparison of MDCs in Subsurface Soil to NOAEL ESLs for Burrowing Receptors in the RCEU

Analyte	MDC	Prairie Dog NOAEL ESL[a]	MDC > ESL?
Inorganics (mg/kg)			
Aluminum	23,700	N/A	UT
Antimony	8.8	18.7	No
Arsenic	13.1	9.35	**Yes**
Barium	187	3,220	No
Beryllium	1.3	211	No
Calcium	54,300	N/A	UT
Cesium	3.4	N/A	UT
Chromium[a]	55.1	703	No
Cobalt	12.8	2,460	No
Copper	380	838	No
Iron	21,400	N/A	UT
Lead	45.7	1,850	No
Lithium	38.2	3,180	No
Magnesium	4,090	N/A	UT
Manganese	355	1,519	No
Mercury	0.16	3.15	No
Nickel	33.4	38.3	No
Potassium	2,630	N/A	UT
Selenium	0.3	2.80	No
Silver	3	N/A	UT
Sodium	107	N/A	UT
Strontium	88.1	3,520	No
Thallium	0.38	204	No
Tin	55.9	80.6	No
Vanadium	50.2	83.5	No
Zinc	38.2	1,170	No
Organics (µg/kg)			
Acetone	68	248,000	No
Methylene Chloride	7	210,000	No
Toluene	70	1.22E+06	No
Radionuclides (pCi/g)			
Americium-241	0.0334	3,890	No
Gross Alpha	31.3	N/A	UT
Gross Beta	36.61	N/A	UT
Plutonium-239/240	0.69	6,110	No
Uranium-233/234	3.2	4,980	No
Uranium-235	0.1812	2,770	No
Uranium-238	3.1	1,580	No

[a] The ESL for chromium (VI) is used.

N/A = Indicates no ESL was available for that ECOI/receptor pair.

UT = Uncertain toxicity; no ESL available (assessed in Section 10).

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.13

Statistical Distribution and Comparison to Background for Subsurface Soil in the RCEU

Analyte	Statistical Distribution Testing Results						Background Comparison Test Results		
	Background Data Set			RCEU Data Set					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Retain as ECOI?
Inorganics (mg/kg)									
Arsenic	45	NONPARAMETRIC	93	8	NORMAL	100	WRS	0.0150	**Yes**

WRS = Wilcoxon Rate Sum

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.14

Statistical Concentrations in Subsurface Soil in the RCEU

Analyte	Units	Total Samples	UCL Recommended by ProUCL	Distribution Recommended by ProUCL	Mean Concentration	Median Concentration	75th percentile	95th percentile	UCL	UTL	MDC
Arsenic	mg/kg	8	95% Student's-t UCL	NORMAL	8.08	8.15	11.5	13	10.8	13.1	13.1

MDC = Maximum detected concentration or in some cases, maximum proxy result.

UCL = 95% upper confidence limit on the mean, unless the MDC < UCL, then the MDC is used as the UCL.

UTL = 95% upper confidence limit on the 90th percentile value, unless the MDC < UCL, then the MDC is uesed as the UTL.

Table 7.15

Upper-Bound Exposure Point Concentration Comparison to tESLs in the RCEU Subsurface Soil

Analyte	Burrowing Receptors		
	EPC (95UTL)	tESL[a]	EPC>ESL?
Inorganics (mg/kg)			
Arsenic	13.1[b]	9.35	**Yes**

[a] Threshold ESL (if available) for the prairie dog receptor.

[b] The MDC was used as the EPC because the 95UTL was greater than the MDC (MDC = Maximum detected concentration or in some cases, maximum proxy result).

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.16
Summary of ECOPC Screening Steps for Subsurface Soil in the RCEU

Analyte	Exceed Any NOAEL ESL?	Detection Frequency >5%?	Exceed Background?[a]	Upper-Bound EPC > Limiting ESL?	Professional Judgment - Retain?	Retain as ECOPC?
Inorganics						
Aluminum	UT	--	--	--	--	No
Antimony	No	--	--	--	--	No
Arsenic	Yes	Yes	Yes	Yes	No	No
Barium	No	--	--	--	--	No
Beryllium	No	--	--	--	--	No
Calcium	UT	--	--	--	--	No
Cesium	UT	--	--	--	--	No
Chromium	No	--	--	--	--	No
Cobalt	No	--	--	--	--	No
Copper	No	--	--	--	--	No
Iron	UT	--	--	--	--	No
Lead	No	--	--	--	--	No
Lithium	No	--	--	--	--	No
Magnesium	UT	--	--	--	--	No
Manganese	No	--	--	--	--	No
Mercury	No	--	--	--	--	No
Nickel	No	--	--	--	--	No
Potassium	UT	--	--	--	--	No
Selenium	No	--	--	--	--	No
Silver	UT	--	--	--	--	No
Sodium	UT	--	--	--	--	No
Strontium	No	--	--	--	--	No
Thallium	No	--	--	--	--	No
Tin	No	--	--	--	--	No
Vanadium	No	--	--	--	--	No
Zinc	No	--	--	--	--	No
Organics (µg/kg)						
Acetone	No	--	--	--	--	No
Methylene Chloride	No	--	--	--	--	No
Toluene	No	--	--	--	--	No
Radionuclides (pCi/g)						
Americium-241	No	--	--	--	--	No
Gross Alpha	UT	--	--	--	--	No
Gross Beta	UT	--	--	--	--	No
Plutonium-239/240	No	--	--	--	--	No
Uranium-233/234	No	--	--	--	--	No
Uranium-235	No	--	--	--	--	No
Uranium-238	No	--	--	--	--	No

[a] Based on results of statistical analysis at the 0.1 level of significance.

-- = Screen not performed because ECOI was eliminated from further consideration in a previous step.

UT = Uncertain toxicity; no ESL available (assessed in Section 10).

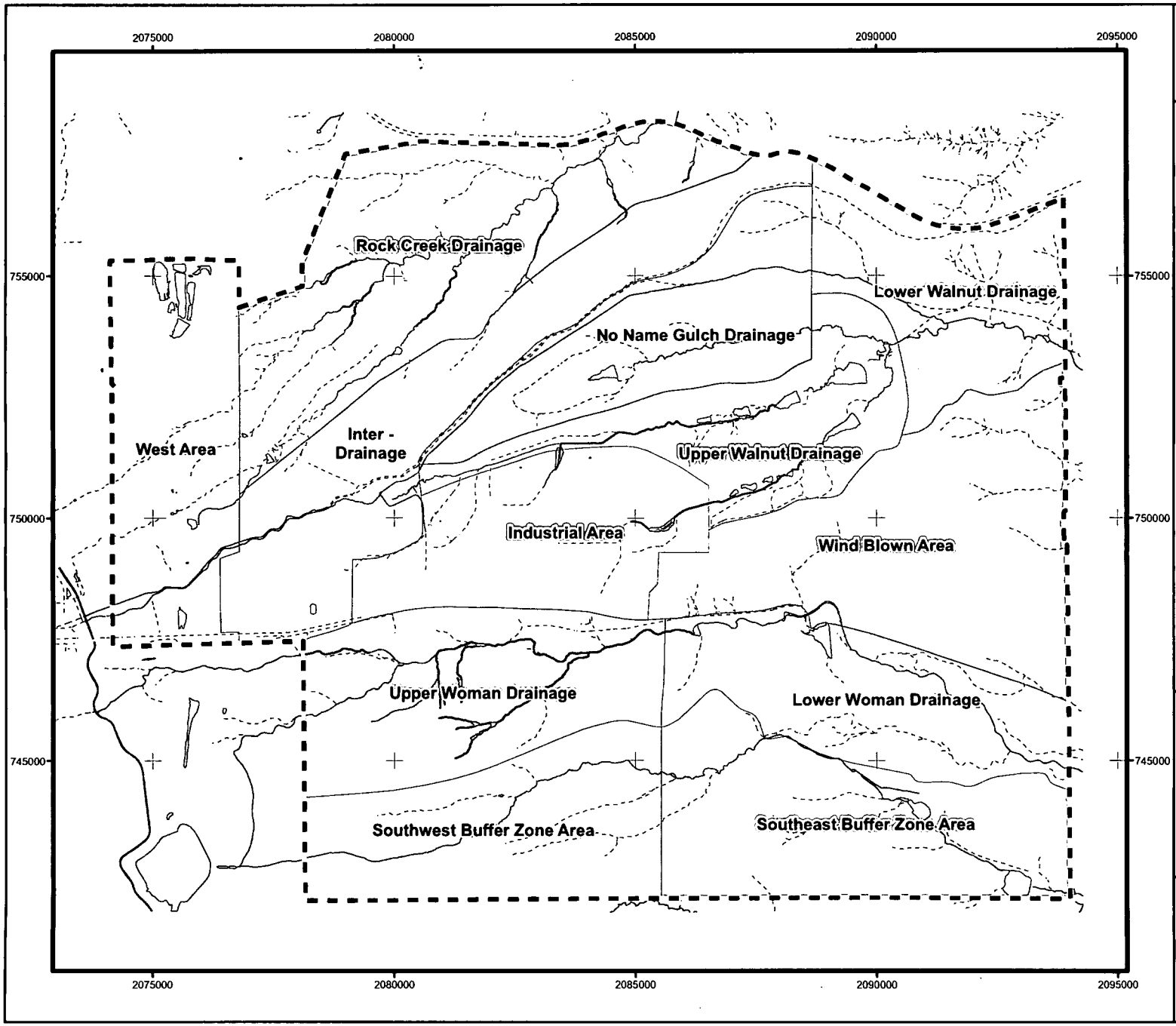

Figure 1.1
Rocky Flats Environmental Technology Site
Exposure Units

KEY

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
W E
S

0 1,500 3,000
Feet

Scale 1:36,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

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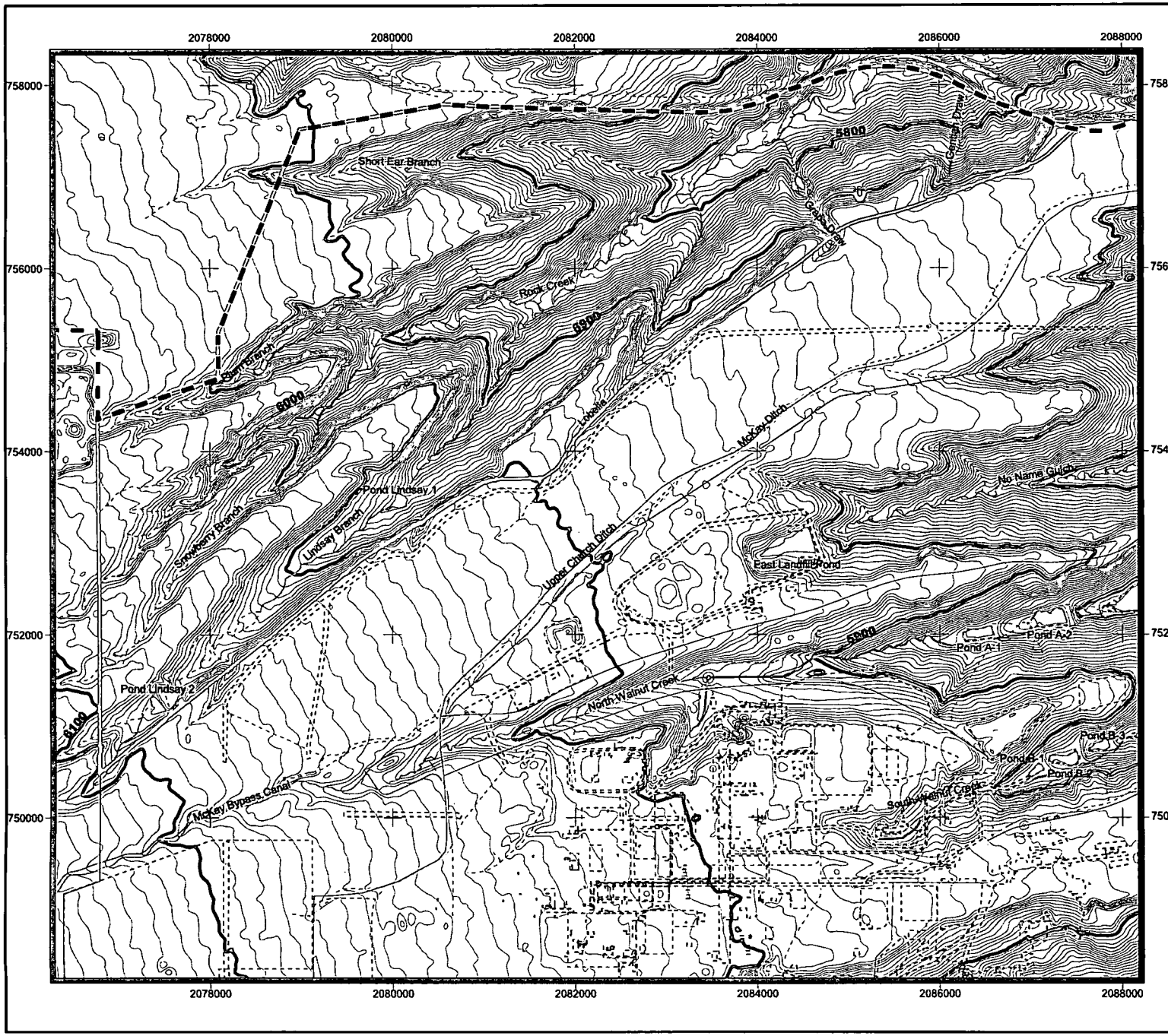

Figure 1.2
Topography and Historical IHSS Locations in the Rock Creek Drainage Exposure Unit

KEY

- Rock Creek Drainage EU
- Historical IHSS/PAC
- Topographic contour interval = 5 ft.

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
W E
S

0 800 1600 Feet

Scale 1:19200

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

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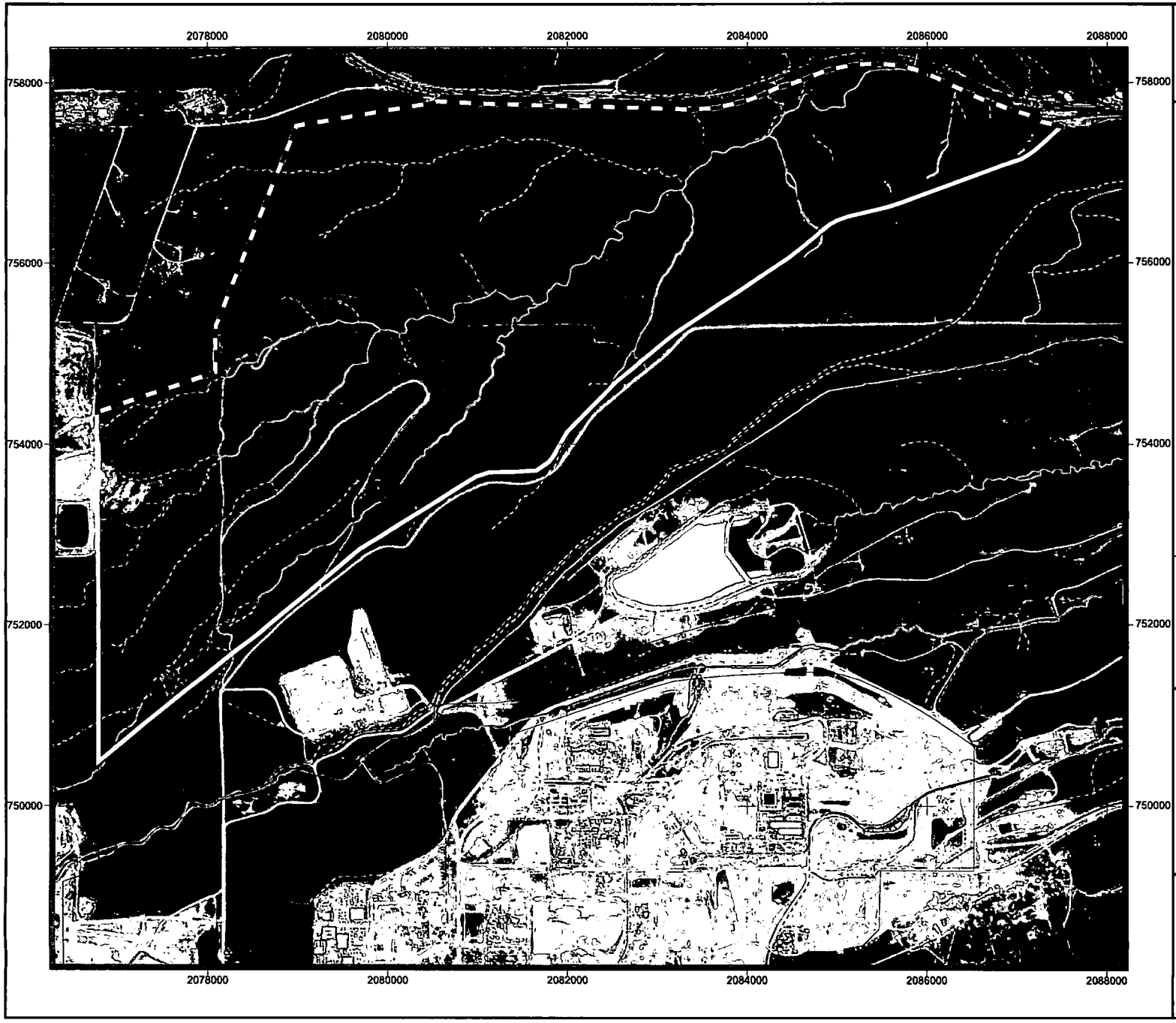

Figure 1.3
Aerial Photograph of the
Rock Creek Drainage Exposure Unit
July 2005

KEY

Rock Creek Drainage EU

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
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0 800 1600 Feet

Scale 1:19200

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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Technology Site

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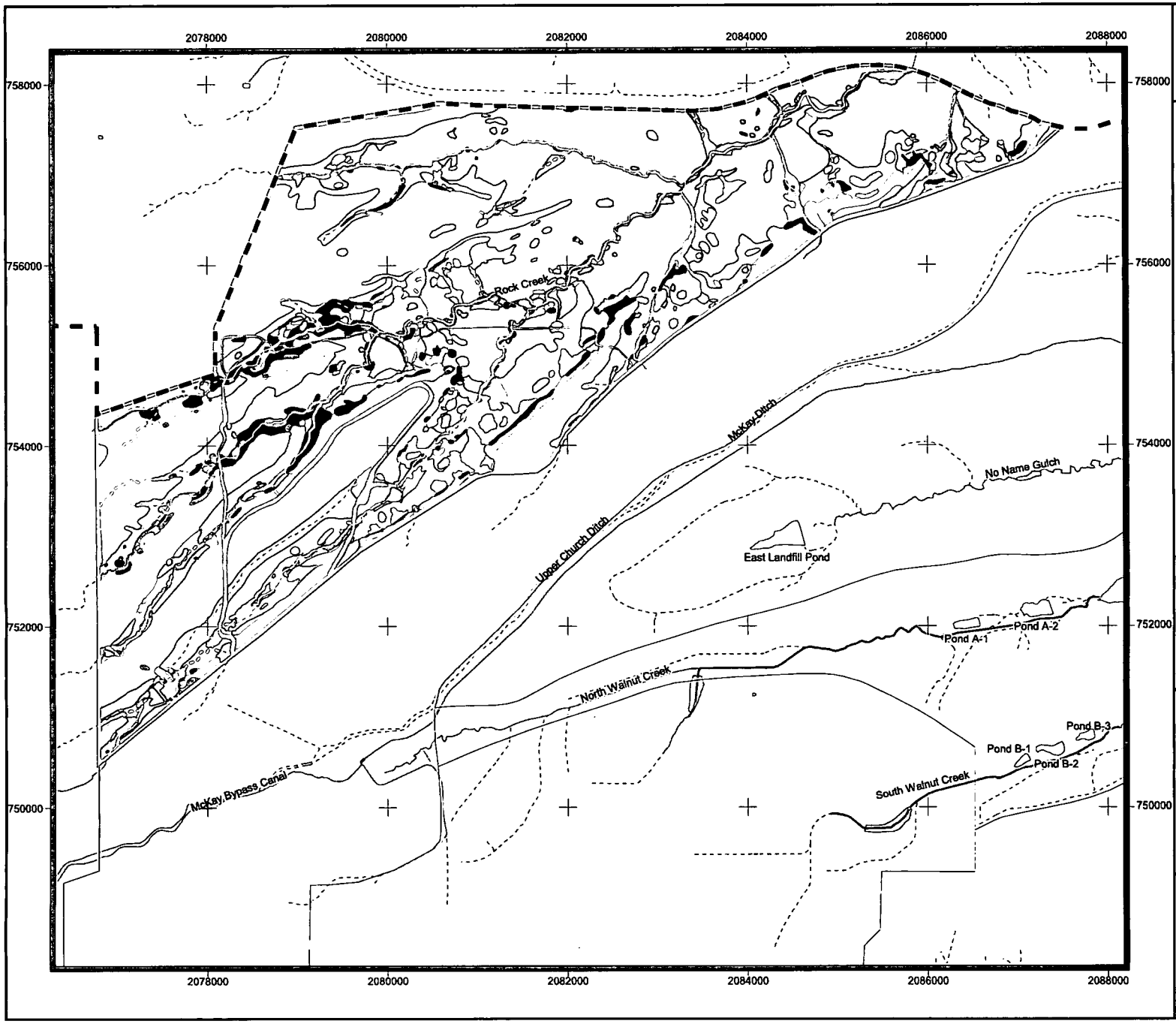

Figure 1.4
Vegetation in the
Rock Creek Drainage
Exposure Unit

KEY

Rock Creek Drainage EU

Vegetation, 1996

- Annual grass/forb community
- Disturbed and developed areas
- Leadplant riparian shrubland
- Mesic mixed grassland
- Mudflats
- Open water
- Ponderosa woodland
- Reclaimed mixed grassland
- Riparian woodland
- Riprap, rock, and gravel piles
- Savannah shrubland
- Short grassland
- Short marsh
- Short upland shrubland
- Tall marsh
- Tall upland shrubland
- Tree plantings
- Wet meadow/marsh ecotone
- Willow riparian shrubland
- Xeric needle and thread grass prairie
- Xeric tallgrass prairie

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

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0 800 1600 Feet

Scale 1:19200

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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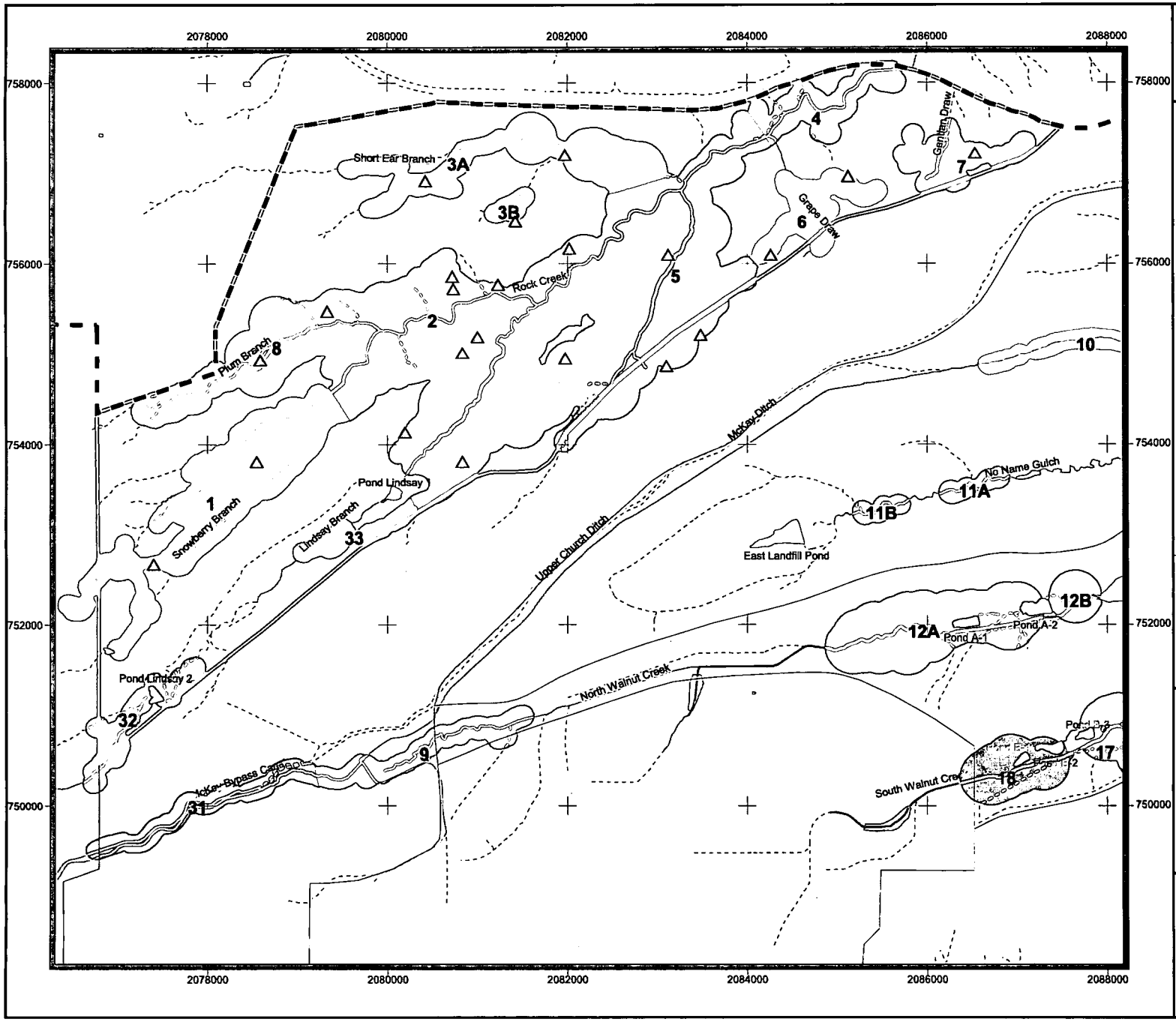

Figure 1.5
Preble's Meadow Jumping Mouse Habitat and Surface Soil Sample Locations in the Rock Creek Drainage Exposure Unit

KEY

- Surface soil sample location
- Rock Creek Drainage EU
- PMJM habitat patch
- 1 PMJM habitat patch ID

Note: Not all analyte groups were analyzed at every sample location.

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

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0 800 1600 Feet

Scale 1:19200

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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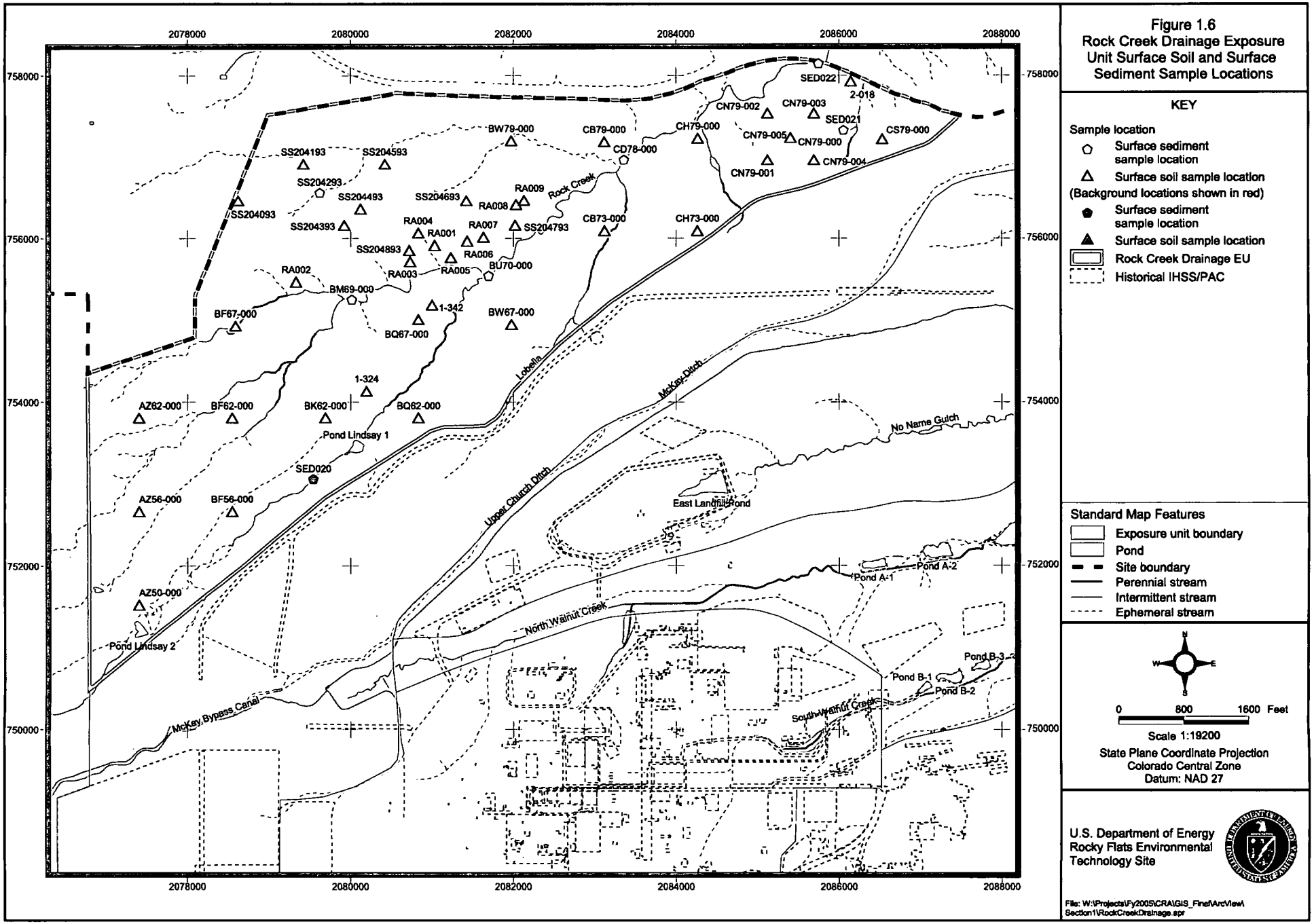

Figure 1.6
Rock Creek Drainage Exposure Unit Surface Soil and Surface Sediment Sample Locations

KEY

Sample location
- Surface sediment sample location
- Surface soil sample location

(Background locations shown in red)
- Surface sediment sample location
- Surface soil sample location
- Rock Creek Drainage EU
- Historical IHSS/PAC

Standard Map Features
- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N W E S

0 800 1600 Feet

Scale 1:19200

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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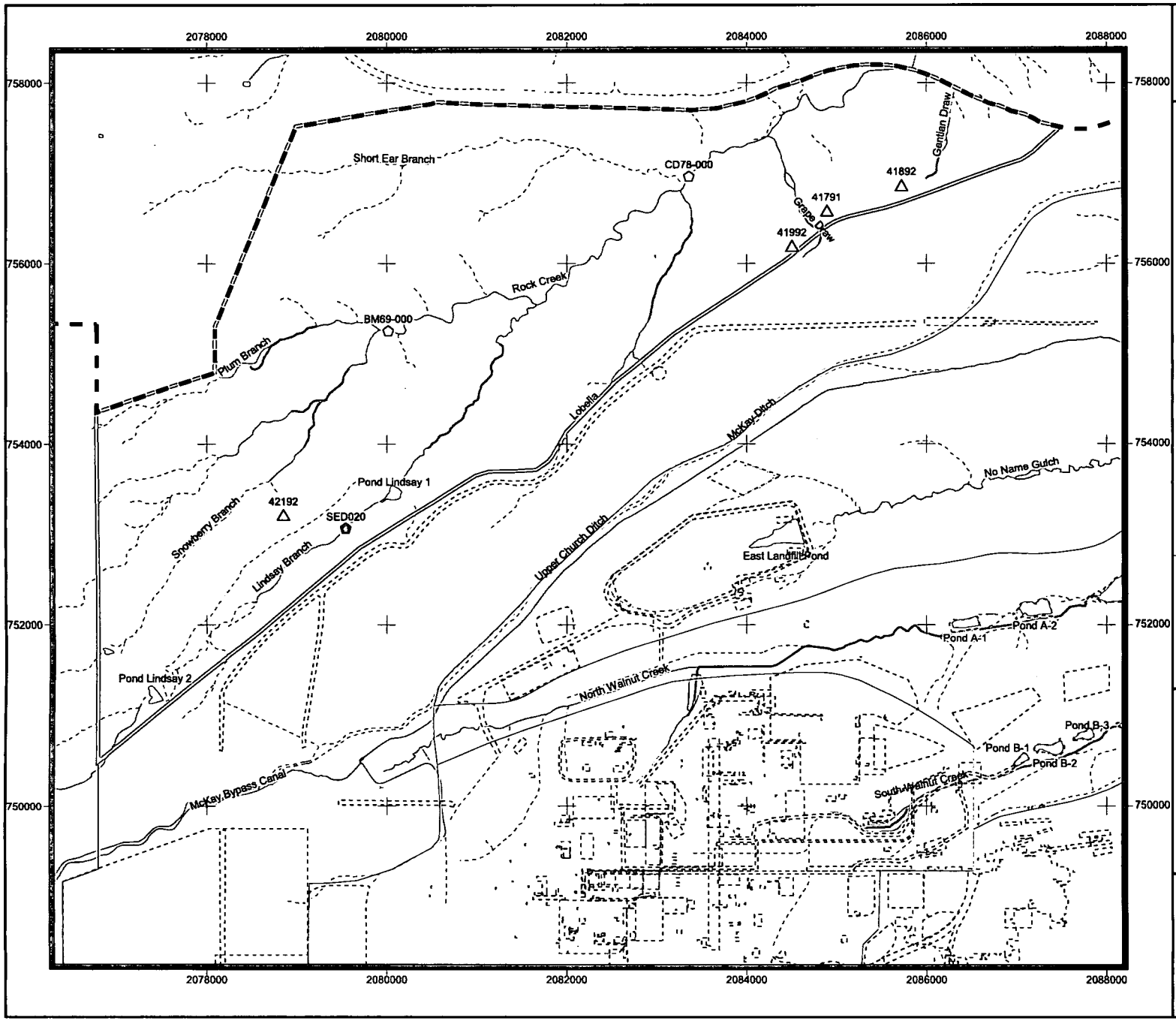

Figure 1.7
Rock Creek Drainage Exposure Unit Subsurface Soil and Subsurface Sediment Sample Locations

KEY

Sample location
- Subsurface sediment sample location
- Subsurface soil sample location

(Background locations shown in red)
- Subsurface sediment sample location
- Subsurface soil sample location
- Rock Creek Drainage EU
- Historical IHSS/PAC

Standard Map Features
- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

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0 800 1600 Feet

Scale 1:19200

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

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COMPREHENSIVE RISK ASSESSMENT

UPPER WOMAN DRAINAGE EXPOSURE UNIT

VOLUME 10: ATTACHMENT 1

Detection Limit Screen

TABLE OF CONTENTS

LIST OF TABLES

VO

ACRONYMS AND ABBREVIATIONS

ECOI	Ecological Contaminant of Interest
ERA	Ecological Risk Assessment
ESL	ecological screening level
HHRA	Human Health Risk Assessment
PCOC	Potential Chemical of Concern
PRG	preliminary remediation goal
UWOEU	Upper Woman Exposure Unit
WRW	Wildlife Refuge Worker

1.0 EVALUATION OF DETECTION LIMITS FOR NONDETECTED ANALYTES IN THE UPPER WOMAN DRAINAGE EXPOSURE UNIT

The detection limits for analytes not detected in, or detected in less than 5 percent of, the samples collected in the media used in the Human Health Risk Assessment (HHRA) or the Ecological Risk Assessment (ERA) are compared to human health preliminary remediation goals (PRGs) for the wildlife refuge worker (WRW) and ecological screening levels (ESLs) for a variety of ecological receptors. The comparisons are made in Tables A1.1 through A1.4 for potential contaminants of concern (PCOCs) in surface soil/surface sediment and subsurface soil/subsurface sediment, and ecological contaminants of interest (ECOIs) in surface soil and subsurface soil. The reported detection limits (referred to as "reported results" in the following sections of this attachment) are listed in these tables for each medium in the Upper Woman Drainage Exposure Unit (UWOEU). When reported results exceed the respective PRGs and ESLs, this is a source of uncertainty in the risk assessment process, and these occurrences are noted and discussed. The reported results are the lowest levels at which the analyte could be accurately and reproducibly quantified, taking into account the sample characteristics, sample collection, sample preparation, and analytical adjustments. The term analyte as used in the following sections refers to analytes that are nondetected or detected in less than 5% of the samples.

1.1 Comparison of Maximum Reported Results to Preliminary Remediation Goals

1.1.1 Surface Soil/Surface Sediment

The maximum reported detection limits for four analytes in surface soil/surface sediment, 3,3-dichlorobenzidine, dibenz(a,h)anthracene, and n-nitroso-di-n-propylamine, and Aroclor-1260 are greater than the PRG (Table A1.1). The minimum reported detections for these analytes are below the PRG. Since the exceedances of the maximum detection limits over the PRG are small, and the detection limits for the majority of the analytes were much lower than the PRG, the uncertainties associated with detection limits greater than the PRGs are not expected to have a significant impact on the results of the risk assessment.

PRGs are not available for two inorganics and several organic analytes in surface soil/surface sediment (Table A1.1). Because PRGs are available for most of the nondetected analytes in surface soil/surface sediment, and the maximum reported results for these analytes are much lower than the PRGs, the lack of PRGs for a few analytes is unlikely to have a significant effect on the results of the risk assessment. In addition, the fact that no identified source exists for these analytes in the UWOEU indicates that the uncertainty associated with the reported results for these analytes is acceptable.

1.1.2 Subsurface Soil/Subsurface Sediment

One analyte in subsurface soil/subsurface sediment, n-nitroso-di-n-propylamine, had a maximum reported results that exceed the PRG in subsurface soil/subsurface sediment (Table A1.2). This is not expected to have a significant effect on the risk assessment.

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PRGs are not available for several organic analytes in subsurface soil/subsurface sediment (Table A1.2). Because PRGs are available for most of the organics in subsurface soil/subsurface sediment, and the maximum reported results for these analytes are much lower than the PRGs, the lack of PRGs for only a few organics is unlikely to have a significant effect on the results of the risk assessment. In addition, the fact that no identified source exists for these analytes in the UWOEU indicates that the uncertainty associated with the reported results for these analytes is acceptable.

1.2 Comparison of Maximum Reported Results to Ecological Screening Levels

1.2.1 Surface Soil

The maximum reported results for several analytes in surface soil are greater than the ESL (Table A1.3). However, a large number of analytes in surface soil have maximum reported results that are much less than the ESLs, indicating that the detection limits are adequate for most analytes. In addition, since there is no indication that the analytes with maximum reported results above the ESLs are present at the UWOEU, this is not expected to impact the conclusions of the risk assessment.

ESLs are not available for several organic analytes in surface soil (Table A1.3). Because ESLs are available for most of the organics in surface soil, and the maximum reported results for these analytes are much lower than the ESLs, the lack of ESLs for these organics is unlikely to have a significant effect on the results of the risk assessment. In addition, the fact that no identified source exists for these analytes in the UWOEU indicates that the uncertainty associated with the reported results for these analytes is acceptable.

1.2.2 Subsurface Soil

The minimum and maximum reported results for all analytes in subsurface soil are below their respective ESLs, except those for 2,4-dinitrotoluene (Table A1.4). This is not expected to impact the results of the risk assessment.

ESLs were not available for several analytes in subsurface soil (Table A1.4). Because the maximum reported results for analytes with ESLs available are generally much lower than the ESLs, suggesting that these analytes are not present at levels near the ESLs, the lack of ESLs for some analytes is not likely to have a significant effect on the results of the risk assessment.

TABLES

Table A1.1

Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Surface Soil/Surface Sediment

Analyte	Range of Reported Results	Total Number of Results	PRG	Maximum Reported Result > PRG?[a]
Inorganics (mg/kg)				
Antimony	0.28 - 29.5	49	44.4	No
Chromium (VI)	0.86 - 0.96	2	28.4	No
Nitrite	0.5 - 0.5	1	11,109	No
Organics (µg/kg)				
1,1,2,2-Tetrachloroethane	5 - 14	6	10,483	No
1,1,2-Trichloroethane	5 - 14	7	28,022	No
1,1-Dichloroethane	5 - 14	8	2.72E+06	No
1,1-Dichloroethene	5 - 14	8	17,366	No
1,2,4-Trichlorobenzene	330 - 2,500	30	151,360	No
1,2-Dichlorobenzene	330 - 1,600	27	2.89E+06	No
1,2-Dichloroethane	5 - 14	8	13,270	No
1,2-Dichloroethene	5 - 14	8	999,783	No
1,2-Dichloropropane	5 - 14	7	38,427	No
1,3-Dichlorobenzene	330 - 2,500	30	3.33E+06	No
1,4-Dichlorobenzene	330 - 1,600	27	91,315	No
2,4,5-Trichlorophenol	1,600 - 8,000	24	8.01E+06	No
2,4,6-Trichlorophenol	330 - 2,500	24	272,055	No
2,4-Dichlorophenol	330 - 2,500	24	240,431	No
2,4-Dimethylphenol	330 - 2,500	24	1.60E+06	No
2,4-Dinitrophenol	1,700 - 13,000	22	160,287	No
2,4-Dinitrotoluene	330 - 2,500	30	160,287	No
2,6-Dinitrotoluene	330 - 2,500	30	80,144	No
2-Chloronaphthalene	330 - 2,500	30	6.41E+06	No
2-Chlorophenol	330 - 2,500	24	555,435	No
2-Hexanone	10 - 28	6	N/A	UT
2-Methylnaphthalene	330 - 2,500	28	320,574	No
2-Methylphenol	330 - 2,500	24	4.01E+06	No
2-Nitroaniline	1,700 - 13,000	30	192,137	No
2-Nitrophenol	330 - 2,500	24	N/A	UT
3,3'-Dichlorobenzidine	660 - 5,000	29	6,667	No
3-Nitroaniline	1,700 - 13,000	29	N/A	UT
4,4'-DDD	16 - 82	26	15,528	No
4,4'-DDE	16 - 82	26	10,961	No
4,4'-DDT	16 - 82	26	10,927	No
4,6-Dinitro-2-methylphenol[b]	**1,700 - 13,000**	**21**	**8,014**	**Yes**
4-Bromophenyl-phenylether	330 - 2,500	30	N/A	UT
4-Chloro-3-methylphenol	330 - 5,000	24	N/A	UT
4-Chloroaniline	330 - 5,000	29	320,574	No
4-Chlorophenyl-phenyl ether	330 - 2,500	30	N/A	UT
4-Methyl-2-pentanone	10 - 28	6	8.32E+07	No
4-Nitroaniline	1,700 - 13,000	29	207,917	No
4-Nitrophenol[b]	1,700 - 13,000	22	641,148	No

Table A1.1

Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Surface Soil/Surface Sediment

Analyte	Range of Reported Results	Total Number of Results	PRG	Maximum Reported Result > PRG?[a]
Acenaphthene	330 - 1,600	30	4.44E+06	No
Acenaphthylene	330 - 1,600	30	N/A	UT
Aldrin	8.2 - 41	26	176	No
alpha-BHC	8.2 - 41	26	570	No
alpha-Chlordane	82 - 410	26	10,261	No
Anthracene	330 - 1,600	30	2.22E+07	No
Benzene	5 - 14	7	23,563	No
Benzo(a)anthracene[b]	330 - 2,500	29	3,793	No
Benzo(a)pyrene[b]	**330 - 2,500**	**28**	**379**	**Yes**
Benzo(b)fluoranthene	330 - 2,500	29	3,793	No
Benzo(g,h,i)perylene	330 - 2,500	23	N/A	UT
Benzo(k)fluoranthene	330 - 2,500	29	37,927	No
Benzyl Alcohol	330 - 5,000	24	2.40E+07	No
beta-BHC	8.2 - 41	26	1,995	No
beta-Chlordane	86 - 400	13	10,261	No
bis(2-Chloroethoxy) methane	330 - 2,500	30	N/A	UT
bis(2-Chloroethyl) ether	330 - 2,500	30	3,767	No
bis(2-Chloroisopropyl) ether	330 - 2,500	30	59,301	No
Bromodichloromethane	5 - 14	7	67,070	No
Bromoform	5 - 14	7	419,858	No
Bromomethane	10 - 28	8	20,959	No
Butylbenzylphthalate	330 - 2,500	30	1.60E+07	No
Carbon Disulfide	5 - 14	8	1.64E+06	No
Carbon Tetrachloride	5 - 14	7	8,446	No
Chlorobenzene	5 - 14	6	666,523	No
Chloroethane	10 - 28	8	1.43E+06	No
Chloroform	5 - 14	8	7,850	No
Chloromethane	10 - 28	8	115,077	No
Chrysene[b]	330 - 2,500	29	379,269	No
cis-1,3-Dichloropropene	5 - 14	7	19,432	No
delta-BHC	8.2 - 41	26	570	No
Dibenz(a,h)anthracene	**330 - 2,500**	**29**	**379**	**Yes**
Dibenzofuran	330 - 2,500	30	222,174	No
Dibromochloromethane	5 - 14	7	49,504	No
Dieldrin	16 - 82	26	187	No
Diethylphthalate	330 - 2,500	30	6.41E+07	No
Dimethylphthalate	330 - 2,500	30	8.01E+08	No
Di-n-octylphthalate	330 - 2,500	29	3.21E+06	No
Endosulfan I	8.2 - 41	26	480,861	No
Endosulfan II	16 - 82	26	480,861	No
Endosulfan sulfate	16 - 82	26	480,861	No
Endrin	16 - 82	26	24,043	No
Endrin ketone	16 - 82	26	33,326	No

Table A1.1

Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Surface Soil/Surface Sediment

Analyte	Range of Reported Results	Total Number of Results	PRG	Maximum Reported Result > PRG?[a]
Ethylbenzene	5 - 14	6	5.39E+06	No
Fluoranthene[b]	330 - 2,500	29	2.96E+06	No
Fluorene	330 - 2,500	30	3.21E+06	No
gamma-BHC (Lindane)	8.2 - 41	26	2,771	No
gamma-Chlordane	82 - 410	13	10,261	No
Heptachlor	8.2 - 41	26	665	No
Heptachlor epoxide	8.2 - 41	26	329	No
Hexachlorobenzene	**330 - 2,500**	**30**	**1,870**	**Yes**
Hexachlorobutadiene	330 - 2,500	30	22,217	No
Hexachlorocyclopentadiene	330 - 2,500	28	380,452	No
Hexachloroethane	330 - 2,500	30	111,087	No
Indeno(1,2,3-cd)pyrene	330 - 2,500	28	3,793	No
Isophorone	330 - 2,500	30	3.16E+06	No
Methoxychlor	82 - 410	26	400,718	No
Naphthalene	330 - 2,500	30	1.40E+06	No
Nitrobenzene	330 - 2,500	24	43,246	No
N-Nitroso-di-n-propylamine	**330 - 2,500**	**30**	**429**	**Yes**
N-nitrosodiphenylamine	330 - 2,500	30	612,250	No
PCB-1016	82 - 410	26	1,349	No
PCB-1221	82 - 410	26	1,349	No
PCB-1232	82 - 410	26	1,349	No
PCB-1242	82 - 410	26	1,349	No
PCB-1248	82 - 410	26	1,349	No
PCB-1254	160 - 820	26	1,349	No
PCB-1260	160 - 820	26	1,349	No
Pentachlorophenol[b]	1,700 - 13,000	23	17,633	No
Phenanthrene[b]	330 - 2,500	29	N/A	UT
Phenol[b]	340 - 3,350	23	2.40E+07	No
Pyrene[b]	330 - 2,500	29	2.22E+06	No
Pyridine	1,600 - 2,500	3	N/A	UT
Styrene	5 - 14	6	1.38E+07	No
Toxaphene	160 - 820	26	2,720	No
trans-1,3-Dichloropropene	5 - 14	7	20,820	No
Vinyl acetate	10 - 28	7	2.65E+06	No
Vinyl Chloride	10 - 28	8	2,169	No

[a] Value is the maximum reported result for nondetected analytes.

[b] Analyte has a detection frequency of less than 5 percent.

N/A = Not available.

UT = Uncertain toxicity.

Bold = Maximum reported result is greater than the PRG.

Table A1.2
Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Subsurface Soil/Subsurface Sediment[a]

Analyte	Range of Reported Results	Total Number of Results	PRG	Max Reported Result ≥ PRG?[b]
Inorganics (mg/kg)				
Nitrate / Nitrite	22.8	1	2.04E+06	No
Uranium	1.2 - 1.3	2	3,833	No
Organics (µg/kg)				
1,1,1-Trichloroethane	5 - 6	12	1.06E+08	No
1,1,2,2-Tetrachloroethane	5 - 6	12	120,551	No
1,1,2-Trichloroethane	5 - 6	12	322,253	No
1,1-Dichloroethane	5 - 6	12	3.12E+07	No
1,1-Dichloroethene	5 - 6	12	199,706	No
1,2,4-Trichlorobenzene	890 - 970	2	1.74E+06	No
1,2-Dichloroethane	5 - 6	12	152,603	No
1,2-Dichloroethene	5 - 6	12	1.15E+07	No
1,2-Dichloropropane	5 - 6	12	441,907	No
1,3-Dichlorobenzene	890 - 970	2	3.83E+07	No
2,4,5-Trichlorophenol	890 - 970	2	9.22E+07	No
2,4,6-Trichlorophenol	890 - 970	2	3.13E+06	No
2,4-Dichlorophenol	890 - 970	2	2.76E+06	No
2,4-Dimethylphenol	890 - 970	2	1.84E+07	No
2,4-Dinitrophenol	4,500 - 4,900	2	1.84E+06	No
2,4-Dinitrotoluene	890 - 970	2	1.84E+06	No
2,6-Dinitrotoluene	890 - 970	2	921,651	No
2-Chloronaphthalene	890 - 970	2	7.37E+07	No
2-Chlorophenol	890 - 970	2	6.39E+06	No
2-Hexanone	11 - 13	12	N/A	UT
2-Methylnaphthalene	890 - 970	2	3.69E+06	No
2-Methylphenol	890 - 970	2	4.61E+07	No
2-Nitroaniline	4,500 - 4,900	2	2.21E+06	No
2-Nitrophenol	890 - 970	2	N/A	UT
3,3'-Dichlorobenzidine	1,800 - 1,900	2	76,667	No
3-Nitroaniline	4,500 - 4,900	2	N/A	UT
4,6-Dinitro-2-methylphenol	4,500 - 4,900	2	92,165	No
4-Bromophenyl-phenylether	890 - 970	2	N/A	UT
4-Chloro-3-methylphenol	1,800 - 1,900	2	N/A	UT
4-Chloroaniline	1,800 - 1,900	2	3.69E+06	No
4-Chlorophenyl-phenyl ether	890 - 970	2	N/A	UT
4-Methyl-2-pentanone	11 - 13	12	9.57E+08	No
4-Methylphenol	890 - 970	2	4.61E+06	No
4-Nitroaniline	4,500 - 4,900	2	2.39E+06	No
4-Nitrophenol	4,500 - 4,900	2	7.37E+06	No
Acenaphthene	450 - 490	2	5.10E+07	No
Acenaphthylene	450 - 490	2	N/A	UT
Anthracene	450 - 490	2	2.55E+08	No
Benzene	5 - 6	12	270,977	No

Table A1.2
Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Subsurface Soil/Subsurface Sediment[a]

Analyte	Range of Reported Results	Total Number of Results	PRG	Max Reported Result > PRG?
Benzo(a)anthracene	890 - 970	2	43,616	No
Benzo(a)pyrene	890 - 970	2	4,357	No
Benzo(b)fluoranthene	890 - 970	2	43,616	No
Benzo(g,h,i)perylene	890 - 970	2	N/A	UT
Benzo(k)fluoranthene	890 - 970	2	436,159	No
Benzoic Acid	4,500 - 4,900	2	3.69E+09	No
Benzyl Alcohol	1,800 - 1,900	2	2.76E+08	No
bis(2-Chloroethoxy) methane	890 - 970	2	N/A	UT
bis(2-Chloroethyl) ether	890 - 970	2	43,315	No
bis(2-Chloroisopropyl) ether	890 - 970	2	681,967	No
bis(2-ethylhexyl)phthalate	890 - 970	2	2.46E+06	No
Bromodichloromethane	5 - 6	12	771,304	No
Bromoform	5 - 6	12	4.83E+06	No
Bromomethane	11 - 13	12	241,033	No
Butylbenzylphthalate	890 - 970	2	1.84E+08	No
Carbon Disulfide	5 - 6	12	1.88E+07	No
Carbon Tetrachloride	5 - 6	12	97,124	No
Chlorobenzene	5 - 6	12	7.67E+06	No
Chloroethane	11 - 13	12	1.65E+07	No
Chloroform	5 - 6	12	90,270	No
Chloromethane	11 - 13	12	1.32E+06	No
Chrysene	890 - 970	2	4.36E+06	No
cis-1,3-Dichloropropene	5 - 6	12	223,462	No
Dibenz(a,h)anthracene	890 - 970	2	4,362	No
Dibenzofuran	890 - 970	2	2.56E+06	No
Dibromochloromethane	5 - 6	12	569,296	No
Diethylphthalate	890 - 970	2	7.37E+08	No
Dimethylphthalate	890 - 970	2	9.22E+09	No
Di-n-butylphthalate	890 - 970	2	9.22E+07	No
Di-n-octylphthalate	890 - 970	2	3.69E+07	No
Ethylbenzene	5 - 6	12	6.19E+07	No
Fluoranthene	890 - 970	2	3.40E+07	No
Fluorene	890 - 970	2	3.69E+07	No
Hexachlorobenzene	890 - 970	2	21,508	No
Hexachlorobutadiene	890 - 970	2	255,500	No
Hexachlorocyclopentadiene	890 - 970	2	4.38E+06	No
Hexachloroethane	890 - 970	2	1.28E+06	No
Indeno(1,2,3-cd)pyrene	890 - 970	2	43,616	No
Isophorone	890 - 970	2	3.63E+07	No
Naphthalene	890 - 970	2	1.61E+07	No
Nitrobenzene	890 - 970	2	497,333	No
N-Nitroso-di-n-propylamine	890 - 970	2	4,929	No
N-nitrosodiphenylamine	890 - 970	2	7.04E+06	No

Table A1.2

Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Subsurface Soil/Subsurface Sediment[a]

Analyte	Range of Reported Results	Total Number of Results	PRG	Max Reported Result > PRG?[b]
Pentachlorophenol	4,500 - 4,900	2	202,777	No
Phenanthrene	890 - 970	2	N/A	UT
Phenol	890 - 970	2	2.76E+08	No
Pyrene	890 - 970	2	2.55E+07	No
Pyridine	890 - 970	2	N/A	UT
Styrene	5 - 6	12	1.59E+08	No
Tetrachloroethene	5 - 6	12	77,111	No
trans-1,3-Dichloropropene	5 - 6	12	239,434	No
Trichloroethene	5 - 6	12	20,354	No
Vinyl acetate	11 - 13	12	3.04E+07	No
Vinyl Chloride	11 - 13	12	24,948	No
Xylene[c]	5 - 6	12	1.22E+07	No

[a] No analytes detected in less than 5 percent of samples.

[b] Value is the maximum reported result for nondetected analytes.

[c] The value for total xylene is used.

N/A = Not available.

UT = Uncertain toxicity.

Table A1.3

Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Surface Soil[a]

Analyte	Range of Reported Detection Limits	Total Number of Results	Lowest ESL	Max Reported Result > ESL?[b]
PCB-1242	**82 - 120**	**17**	**42.3**	**Yes**
PCB-1248	**82 - 120**	**17**	**42.3**	**Yes**
PCB-1254	**160 - 230**	**17**	**42.3**	**Yes**
PCB-1260	**160 - 230**	**17**	**42.3**	**Yes**
Pentachlorophenol	**1,700 - 2,300**	**11**	**122**	**Yes**
Phenanthrene	340 - 480	17	N/A	UT
Phenol	350 - 3,350	11	23,090	No
Pyrene	340 - 480	17	N/A	UT
Toxaphene	160 - 230	17	3,756	No

[a] No analytes detected in less than 5 percent of samples.

[b] Value is the maximum reported result for nondetected analytes.

N/A = Not available.

UT = Uncertain toxicity.

Bold = Maximum reported result is greater than the ESL.

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Table A1.4

Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Subsurface Soil [a]

Analyte	Range of Reported Results	Total Number of Results	Prairie Dog NOAEL ESL	Max Reported Result > ESL? [b]
Inorganics (mg/kg)				
Molybdenum	0.99 - 5.1	4	27.1	No
Organics (µg/kg)				
1,1,1-Trichloroethane	5 - 6	12	4.85E+07	No
1,1,2,2-Tetrachloroethane	5 - 6	12	4.70E+06	No
1,1,2-Trichloroethane	5 - 6	12	N/A	UT
1,1-Dichloroethane	5 - 6	12	215,360	No
1,1-Dichloroethene	5 - 6	12	1.28E+06	No
1,2-Dichloroethane	5 - 6	12	2.00E+06	No
1,2-Dichloroethene	5 - 6	12	1.87E+06	No
1,2-Dichloropropane	5 - 6	12	3.92E+06	No
2-Butanone	11 - 13	12	4.94E+07	No
2-Hexanone	11 - 13	12	N/A	UT
4-Methyl-2-pentanone	11 - 13	12	859,131	No
Benzene	5 - 6	12	1.10E+06	No
Bromodichloromethane	5 - 6	12	381,135	No
Bromoform	5 - 6	12	198,571	No
Bromomethane	11 - 13	12	N/A	UT
Carbon Disulfide	5 - 6	12	410,941	No
Carbon Tetrachloride	5 - 6	12	736,154	No
Chlorobenzene	5 - 6	12	413,812	No
Chloroethane	11 - 13	12	N/A	UT
Chloroform	5 - 6	12	560,030	No
Chloromethane	11 - 13	12	N/A	UT
cis-1,3-Dichloropropene	5 - 6	12	222,413	No
Dibromochloromethane	5 - 6	12	389,064	No
Ethylbenzene	5 - 6	12	N/A	UT
Styrene	5 - 6	12	1.53E+06	No
Tetrachloroethene	5 - 6	12	72,494	No
trans-1,3-Dichloropropene	5 - 6	12	222,413	No
Trichloroethene	5 - 6	12	32,424	No
Vinyl acetate	11 - 13	12	730,903	No
Vinyl Chloride	11 - 13	12	6,494	No
Xylene [c]	5 - 6	12	111,663	No

[a] No analytes detected in less than 5 percent of samples.

[b] Value is the maximum reported result for nondetected analytes.

[c] The value for total xylene is used.

NA = Not Available or Not Applicable.

UT = Uncertain toxicity.

COMPREHENSIVE RISK ASSESSMENT

ROCK CREEK EXPOSURE UNIT

VOLUME 4: ATTACHMENT 2

Data Quality Assessment

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ACRONYMS AND ABBREVIATIONS

AA	atomic absorption
AI	adequate intake
ASD	Analytical Services Division
COC	contaminant of concern
CRA	Comprehensive Risk Assessment
CRDL	contract required detection limit
DER	duplicate error ratio
DQA	Data Quality Assessment
DQO	data quality objective
DRC	data review checklist
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
EU	Exposure Unit
IAG	Interagency Agreement
ICP	inductively couple plasma
IDL	instrument detection limit
LCS	laboratory control sample
MDA	minimum detectable activity
MDL	method detection limit
MS	matrix spike
MSA	method of standard additions
MSD	matrix spike duplicate

NIST	National Institute of Standards Technology
PARCC	precision, accuracy, representativeness, completeness, and comparability
PPT	Pipette
PCB	polychlorinated biphenyl
QC	quality control
RCEU	Rock Creek Drainage Exposure Unit
RDL	required detection limit
RFEDS	Rocky Flats Environmental Data System
RFETS	Rocky Flats Environmental Technology Site
RI/FS	Remedial Investigation/Feasibility Study
RL	reporting limit
RPD	relative percent difference
SDP	standard data package
SOW	Statement of Work
SVOC	semi-volatile organic compound
SWD	Soil Water Database
TCLP	Toxicity Characteristic Leaching Procedure
TIC	tentatively identified compound
V&V	verification and validation
VOC	volatile organic compound

EXECUTIVE SUMMARY

This document provides an assessment of the quality of the data used in the Rock Creek Drainage Exposure Unit (EU) (RCEU) Comprehensive Risk Assessment (CRA). This Data Quality Assessment (DQA) focuses on all elements of quality control (QC) including both laboratory and sample-specific QC data.

Depending on the matrix and analyte group, anywhere from 77 to 100 percent of the RCEU data have been verified and/or validated by a validator from the Analytical Services Division (ASD) at the Rocky Flats Environmental Technology Site (RFETS) (or from an outside subcontractor) using verification and validation (V&V) guidelines for each analytical method developed for RFETS. V&V data are identified in the RFETS Soil Water Database (SWD) by a data qualifier flag and reason code(s) that provide an explanation for the qualifier flag. All rejected data have been removed from the data set used in the CRA because the validator has determined the data are unusable. The remaining V&V data have associated qualifier flags indicating that the data are valid, estimated, or undetected, and are used in the CRA. Of the RCEU V&V data, approximately 17 percent was qualified as estimated and/or undetected. Less than 3 percent of the data reported as detected by the laboratory were qualified as undetected due to blank contamination. Data qualified as estimated or undetected are a result of various minor laboratory noncompliance issues that are insufficient to render the data unusable. A review of the RCEU V&V data indicates that the data meet the data quality objectives (DQOs) outlined in the Final CRA Work Plan and Methodology (K-H 2004) (hereafter referred to as the CRA Methodology) and, therefore, are adequate for use in the CRA. All non-V&V data were used as provided by the laboratory. A review of the RCEU V&V data indicates that the data meet the DQOs outlined in the Final CRA Work Plan and Methodology (K-H 2004) (hereafter referred to as the CRA Methodology). All non-V&V data were used as provided by the laboratory. A review of the most common observations found in the V&V data determined that a minimal amount, less than 1 percent, of the non-V&V data may have been qualified if a review had been performed. Based on this DQA, data for the RCEU are of sufficient quality for use in the CRA.

1.0 INTRODUCTION

The Rock Creek Drainage Exposure Unit (EU) (RCEU) Comprehensive Risk Assessment (CRA) for the Rocky Flats Environmental Technology Site (RFETS) has been prepared in accordance with the CRA Methodology. The CRA Methodology was developed jointly with the regulatory agencies using the consultative process, and was approved by the agencies on September 28, 2004. Consistent with the CRA Methodology, data quality was assessed using a standard precision, accuracy, representativeness, completeness, and comparability (PARCC) parameter analysis (EPA 2002). Both laboratory and field quality control (QC) were evaluated for the RCEU data set.

Although many of the elements of QC that are reviewed in this document affect more than one PARCC parameter, their major impact on data quality is described below:

- Precision, as a measure of agreement among replicate measurements, is determined quantitatively based on the results of replicate laboratory measurements. Precision of the laboratory data was verified through review of:
  - Relative percent differences (RPDs) for laboratory control samples (LCSs) and LCS duplicates compared to the acceptable ranges (analytical precision);
  - RPDs (nonradionuclides) and duplicate error ratios (DERs) (radionuclides) for field sample and field duplicates compared to the acceptable ranges[1] (field precision);
  - RPDs for matrix spike (MS) and matrix spike duplicates (MSDs) compared to acceptable control ranges (matrix precision); and
  - RPDs for primary- and second-column analyses (analytical precision).
- Accuracy, as a measure of the distortion of a measurement process that causes error in measuring the true value, is determined quantitatively based on the analysis of samples with a known concentration. Accuracy of the laboratory data was verified through review of:
  - LCS data, calibration verification data, internal standard data, and instrument tune parameters (laboratory accuracy); and
  - Surrogate recoveries, MSs, and sample preparation (sample-specific accuracy).
- Representativeness of the data was verified through review of:

[1] The CRA Methodology states that the overall precision of the data is considered adequate if the RPD between the target and duplicate, at concentrations five times the reporting limit (RL), is less than 35 percent for solids and 20 percent for liquids. The precision adequacy requirement for radiological contaminants is a DER less than 1.96.

- Laboratory blank data;
- Sample preservation/storage;
- Adherence to sample holding times;
- Documentation issues;
- Contract noncompliance issues; and
- Laboratory activities affecting ability to properly identify compounds.

- Completeness is a data adequacy criterion and is addressed in Appendix A, Volume 2 of the Resource Conservation and Recovery Act (RCRA) Facility Investigation-Remedial Investigation/Corrective Measures Study (CMS)-Feasibility Study (RI/FS) Report (hereafter referred to as the RI/FS Report). It refers to the spatial and temporal distribution of the data, and their adequacy for estimating exposure point concentrations (EPCs) for the CRA.

- Comparability of the data was verified through evaluation of:
  - Analytical procedures, and whether they were standard U.S. Environmental Protection Agency (EPA)- and RFETS-approved procedures;
  - Instrument types and maintenance, sample preparation techniques, and standard units for reporting; and
  - MS and surrogate samples, ensuring accuracy within acceptable ranges.

2.0 ANALYTICAL DATA

Approximately 16,500 specific analytical records exist in the RCEU CRA data set, some 89 percent of which (14,639 records) has undergone verification and validation (V&V). The fraction of the data that was verified and/or validated is shown in Table A2.1 by analyte group and matrix. These data were reviewed by validators and their observations and comments are captured in the Soil Water Database (SWD). All of the data that have been flagged due to V&V findings (except "R"-flagged data) and data that have no flags as a result of V&V are used in the RCEU CRA. The small amount of data that has not undergone V&V is used as provided by the laboratories. The most common errors found during V&V such as transcription errors, calculation errors, and excluded records that were later added by the validator were reviewed to determine the possible effect on non-V&V data. It was determined that less than 1 percent of the entire RCEU data set is at risk for such unacknowledged and, therefore, uncorrected errors.

Data V&V involves an in-depth review of the data packages from the laboratory to assess compliance with contract requirements. In general, data validation includes all of the activities of verification, as well as additional QC checks and review of some raw

laboratory instrument data and calculations. After V&V, a data qualifier flag and/or reason code(s) are assigned to the data record (Tables A2.2 and A2.3). The reason codes provide an explanation for the qualifier flag, thereby making it possible to determine which of the PARCC parameters is affected by the observation (Table A2.4). Qualifier flags are discussed in this Data Quality Assessment (DQA) as those V&V flags that note issues in the data. V&V flags "V," "V1," and "1" represent data that were reviewed by validators, but no issues were observed. Seventy-nine percent of the V&V data fall into this category. Additional qualifier flags such as "A," "E," and "Z" were also applied. These validation qualifiers are notations that do not indicate estimation or a change in the status of detection. The data are valid and useable as reported by the laboratory. Four percent of the V&V data are represented by these additional qualifier flags. The specific definitions of these additional V&V flags are presented in Table A2.2. Data with noted issues are presented in Table A2.5 and discussed in detail in Section 3.0.

V&V qualifier flags are not specifically addressed in this data assessment, but rather the reason codes associated with the qualifier flags for each analytical record are summarized and evaluated. This approach was chosen because the validator's specific observations (reason codes), and not the qualifier flags, provide the best descriptors of the data quality.

V&V data records contain a field with V&V reason codes (5, 18/52, 200, 99/101/701, and so forth), or the field is null. These reason codes represent observations related to assessment of precision, accuracy, and representativeness. For example, the reason code 110 definition (see Table A2.3) is "LCS recovery criteria were not met," which is an observation related to data accuracy.

Multiple reason codes were routinely applied to a specific sample method/matrix/analyte combination. Therefore, it was necessary to parse out the individual codes to create a table that included a unique record identifier and the associated parsed data V&V reason code (5, 18, 52, 200, 99, 101, 701, and so forth). With this information and the data V&V reason code definitions, the data validator's observations related to this data set can be re-created for each analytical record.

To summarize the reason codes in a logical manner for presentation, it was first necessary to group the reason codes that have slightly different definitions but convey the same meaning. A standardized definition was then applied to the individual reason codes within the group. The grouped reason codes were also assigned a QC category (for example, blanks, calibration, and holding time), and the affected PARCC parameter (Table A2.4). The reason codes were then summarized for each medium and analyte group within each QC category, applying the standardized definition to the summarized codes. The summary is presented in Table A2.5.

Rejected data (data qualifier flag "R"), consisting of approximately 7 percent of all V&V data, have been removed from the data used in the RCEU CRA because the validator has determined the data to be unusable. The fraction of the data that was rejected during validation and/or verification is shown in Table A2.6 by analyte group and matrix.

Finally, evaluating the RPD (DER for radionuclides) between a target sample and the associated field duplicate is not a QC parameter performed during V&V, but is still an important analysis when determining data precision. Because this analysis was not performed during V&V, the target sample/field duplicate RPD and DER calculations were performed separately and are presented in Table A2.7 as the number of exceedances per analyte group/matrix combination. Only those analyte group/matrix combinations having records that met the criteria for calculating an RPD or DER are presented. RPDs and DERs for target sample/field duplicate analyte pairs where one or both of the results are less than five times the RL are not calculated as outlined in the CRA Methodology.

3.0 FINDINGS

V&V observations affecting the CRA data set are summarized by analyte group/matrix/QC category/V&V observation in Table A2.5. The detected and nondetected results are summarized separately to give the reader a better idea of the impact on data usability. Only those issues observed in notable percentages (generally greater than 5 percent) of the data are discussed below in further detail. RPDs (DERs for radionuclides) presented in Table A2.7 are only discussed below when RPD (DER for radionuclides) exceedances of control criteria are greater than 10 percent for any given analyte group/matrix combination. Instances of elevated rates (greater than 10 percent) of rejected data are also discussed below.

3.1 Herbicides – Soil

Holding time issues resulted in data V&V qualifications related to this analyte group/matrix combination. While the percentage of all qualifications is high, it is important to note that all data were qualified as usable, although estimated. In addition, although a high percentage of the data related to this analyte group and matrix was rejected during V&V, it is important to note that 100 percent of the associated data were validated and/or verified.

3.2 Metals – Soil

Blank, calibration, documentation, instrument setup, LCS, matrix, and other observations resulted in data V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low with the exception of those records qualified due to low LCS and predigestion MS recoveries, and expired instrument detection limit (IDL) studies. While the importance of these three QC parameters should not be overlooked, it is also important to note that the data were qualified as usable, although estimated.

3.3 Metals – Water

Blank, calculation error, calibration, documentation, holding time, instrument setup, LCS, matrix, sample preparation, sensitivity, and other observations resulted in V&V qualifications associated with this analyte group/matrix combination. The percentage of

all observations is low with the exception of those records qualified due to transcription errors. Transcription errors, however, have no impact on data quality as all issues have previously been evaluated and corrected.

3.4 Polychlorinated Biphenyls (PCBs) – Soil

Documentation, holding time, surrogate, and other issues resulted in data V&V observations related to this analyte group/matrix combination. While the percentage of noted transcription errors is high, the impact on data quality is minimal. All transcription errors have previously been evaluated and corrected. While the importance of observing the allowed sample holding time and surrogate analyses should not be overlooked, it is also important to note that the data were qualified as usable, although estimated. Finally, although 16 percent of the V&V data for this analyte group/matrix combination was rejected, 96 percent of all associated data underwent V&V. This leaves less than 1 percent of the data for this analyte group/matrix combination that may have been rejected if a review had been performed.

3.5 Pesticides – Soil

Documentation, holding time, surrogate, and other observations resulted in data V&V qualifications related to this analyte group/matrix combination. With the exception of those records qualified due to surrogate analyses or allowed sample holding times, the percentage of observations is low. While the importance of these two QC parameters should not be overlooked, it is also important to note that the data were qualified as usable, although estimated. Although 16 percent of the V&V data for this analyte group/matrix combination were rejected, 96 percent of all associated data underwent V&V. This leaves less than 1 percent of the data for this analyte group/matrix combination that may have been rejected if a review had been performed.

3.6 Radionuclides – Soil

Blank, calculation error, calibration, documentation, holding time, instrument setup, LCS, matrix, sensitivity, and other observations resulted in V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low with few exceptions. Insufficient documentation indicates that a complete V&V evaluation may not have been performed, but it is important to note that the data were qualified as usable, although estimated. Transcription errors and validator-calculated minimum detectable activities (MDAs) have no effect on data quality as all issues have previously been evaluated and corrected. While the importance of blank and continuing calibration verification analyses should not be overlooked, it is important to note that these records were also qualified as usable, although estimated. Most of those records qualified as directing the data user to the hard copy validation report for further explanation of the observation were also qualified as estimated. The CRA is performed with this uncertainty in mind, and no further effort was made to identify the issues. Finally, although 17 percent of the V&V data for this analyte group/matrix combination were rejected, 94 percent of all associated data underwent V&V. This leaves approximately 1 percent of

the data related to this analyte group/matrix combination that may have been rejected if a review had been performed.

3.7 Radionuclides – Water

Blank, calculation error, calibration, documentation, holding time, instrument setup, LCS, matrix, sample preparation, sensitivity, and other observations resulted in V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low with few exceptions. Insufficient documentation indicates that a complete V&V evaluation may not have been performed, but it is important to note that the data were qualified as usable, although estimated. Transcription errors and validator-calculated MDAs have no effect on data quality because all issues have previously been evaluated and corrected. While the importance of blank and other QC analyses including continuing calibration verifications, LCSs, and MS/MSDs should not be overlooked, it is important to note that these records were also qualified as usable, although estimated. Most of those records qualified as directing the data user to the hard copy validation report for further explanation of the observation were also qualified as estimated. The CRA is performed with this uncertainty in mind, and no further effort was made to identify the issues. Finally, although 22 percent of the V&V data for this analyte group/matrix combination were rejected, 86 percent of all associated data underwent V&V. This leaves only approximately 3 percent of the data for this analyte group/matrix combination that may have been rejected if a review had been performed.

3.8 Semi-Volatile Organic Compounds (SVOCs) – Soil

Blanks, calibration, holding time, internal standard, and matrix observations resulted in V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low with the exception of those records qualified because the allowed sample holding time was exceeded. Although the importance of this observation should not be overlooked, it is important to note that the data were qualified as usable. In addition, 11 percent of the V&V data associated with this analyte group and matrix were rejected. However, greater than 99 percent of the CRA data associated with this analyte group and matrix were either validated and/or verified, leaving less than 1 percent that may have been rejected if a review had been performed.

3.9 Semi-Volatile Organic Compounds – Water

Blank and calibration issues resulted in V&V observations related to this analyte group/matrix combination. The percentage of observations is low and within method expectations.

3.10 Volatile Organic Compounds (VOCs) – Soil

Blank, calibration, documentation, holding time, internal standard, matrix, and surrogate issues resulted in V&V observations related to this analyte group/matrix combination. The percentage of observations is low with the exception of those records qualified

because the internal standards did not meet control criteria. While the importance of internal standards should not be overlooked, it is also important to note that the data were qualified as usable, although estimated. In addition, almost 14 percent of the V&V data associated with this analyte group and matrix were rejected. However, greater than 77 percent of the CRA data associated with this analyte group and matrix were either validated and/or verified, leaving only approximately 3 percent that may have been rejected if a review had been performed.

3.11 Volatile Organic Compounds – Water

Blank, calibration, confirmation, documentation, holding time, internal standard, LCS, and surrogate issues resulted in V&V observations related to this analyte group/matrix combination. The percentage of observations is low with the exception of those records qualified due to a transcription error. Transcription errors, however, have no effect on data quality as all issues have previously been evaluated and corrected.

3.12 Wet Chemistry Parameters – Soil

Documentation, holding time, matrix, and other issues resulted in V&V observations related to this analyte group/matrix combination. The percentage of observations relating to predigestion MS recoveries, and quarterly IDL studies is high, but it is important to note that this analyte group contains numerous general chemistry parameters having little or no impact on site characterization.

3.13 Wet Chemistry Parameters – Water

Blank, calibration, documentation, holding time, matrix, sample preparation, and other issues resulted in V&V observations related to this analyte group/matrix combination. The percentage of all observations is low and within method expectations.

4.0 CONCLUSIONS

The quality of the laboratory results were evaluated for compliance with the CRA Methodology data quality objectives (DQOs) through an overall review of PARCC parameters.

Of the data used in the RCEU CRA, approximately 88 percent underwent the V&V process. Of that 88 percent, 79 percent was qualified as having no QC issues, and approximately 17 percent was qualified as estimated or undetected (Table A2.8). The remaining 4 percent of the V&V data are made up of records qualified with additional flags indicating acceptable data such as "A," "E," or "P." Approximately 3 percent of the data reported as detected by the laboratory were flagged as undetected by the validators due to blank contamination (Table A2.9). Data qualified as estimated or undetected indicate some issues with PARCC parameters, but not to a degree sufficient to mark the

data unusable. Approximately 7 percent of the entire data set was rejected during the V&V process (Table A2.6).

Although many of the elements of QC that are reviewed in this document affect more than one PARCC parameter, the general discussion below summarizes the data quality per the validation reason codes affecting each specific PARCC parameter. Several V&V reason codes have no real impact on data quality because they represent issues that were noted but corrected, or represent observations related to missing documentation that was not required for data assessment. Approximately 15 percent of the RCEU V&V data were flagged with these "Other" V&V observations.

- Precision, as a measure of agreement among replicate measurements, is determined quantitatively based on the results of replicate laboratory measurements.

  Of the V&V data, approximately three percent was noted for observations related to precision. Of that 3 percent, 97 percent was qualified for issues related to sample matrices and the remaining 3 percent was qualified for issues related to result confirmation or instrument sensitivity. No LCS or instrument setup issues related to precision were noted.

  RPDs and DERs for target sample/field duplicate pairs were found to be acceptable for all analyte group/matrix combinations. Overall, the method precision was found to be generally acceptable.

- Accuracy is a measure of the distortion of a measurement process that causes error in the true value.

  Of the V&V data, 37 percent was noted for accuracy-related observations. Of that 37 percent, 74 percent was noted for laboratory practice-related observations, while sample-specific accuracy observations make up the other 26 percent. Although the percentage of data with noted accuracy issues is slightly elevated, it is important to note that the majority of the data qualified for these accuracy-related observations are flagged as estimated and the CRA is performed with this uncertainty in mind.

  Accuracy was generally acceptable with infrequent performance outside QC limits.

- Representativeness of the data was verified.

  Of the V&V data, approximately 43 percent was noted for observations related to representativeness. Of that 43 percent, 74 percent was qualified for blank observations, 17 percent for failure to observe allowed holding times, 2 percent for sensitivity issues, and 3 percent for documentation issues. Instrument setup, LCS, matrix, sample preparation, and other observations make up the other 4 percent of the data qualified for observations related to sample representativeness.

Reportable levels of target analytes were not routinely detected in the laboratory blanks greater than the laboratory RLs except for relatively isolated incidences. Samples were generally stored and preserved properly. Overall, these elements of QC exceedances are indicative of normal laboratory operations and have little impact the sample data as reported.

Sample data are representative of the site conditions at the time of sample collection.

- Comparability of the data was reviewed and no systematic errors were noted.
  - The use of standard EPA- and RFETS-approved analytical procedures;
  - Instrument types and maintenance, sample preparation techniques, and standard units for reporting; and
  - Evaluation of MS and surrogate samples, ensuring accuracy within acceptable ranges.

  Examination of these parameters did not show any systematic issues with comparability.

- Completeness, as defined in the CRA Methodology, is addressed in Appendix A, Volume 2 of the RI/FS Report.

  Another indication of completeness that is sometimes used is a measure of the number of valid measurements obtained in relation to the total number of measurements planned.

  Because only 7 percent of the overall data were rejected, the use of non-V&V data for the RCEU CRA does not contribute to any completeness issues.

This review concludes that the PARCC of the data are generally acceptable and the CRA objectives have been met.

5.0 REFERENCES

K-H, 2004. Final Comprehensive Risk Assessment Work Plan and Methodology, Environmental Restoration, Rocky Flats Environmental Technology Site, Golden, Colorado. September.

EPA, 2002. Guidance for Quality Assurance Project Plans. EPA QA/G-5, EPA/240/R-02/009. Office of Environmental Information, Washington, D.C. December.

TABLES

qD

Table A2.1
CRA Data V&V Summary

Analyte Group	Matrix	Total No. of V&V Records	Total No. of CRA Records	Percent V&V (%)
Herbicide	SOIL	25	25	100.00
Herbicide	WATER	2	2	100.00
Metal	SOIL	1,707	1,771	96.39
Metal	WATER	4,652	5,301	87.76
PCB	SOIL	175	182	96.15
PCB	WATER	14	14	100.00
Pesticide	SOIL	529	550	96.18
Pesticide	WATER	42	42	100.00
Radionuclide	SOIL	441	470	93.83
Radionuclide	WATER	701	815	86.01
SVOC	SOIL	1,760	1,770	99.44
SVOC	WATER	148	187	79.14
VOC	SOIL	769	779	98.72
VOC	WATER	3,023	3,905	77.41
Wet Chemistry	SOIL	52	52	100.00
Wet Chemistry	WATER	599	668	89.67
	Total	**14,639**	**16,533**	**88.54%**

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Table A2.2
V&V Qualifier Flag Definitions

Validation Qualifier Code	Description
1	QC data from a data package – Verification
A	Data acceptable with qualifications
B	Compound was found in BLK and sample
C	Calibration
E	Associated value exceeds calibration range; dilute and reanalyze
J	Estimated quantity – Validation
J1	Estimated quantity – Verification
JB	Organic method blank contamination – Validation
JB1	Organic method blank contamination – Verification
N	Historical – Validators asked not to validate this
NJ	Associated value is presumptively estimated
NJ1	Value presumptively estimated – Verification
P	Systematic error
R	Data unusable – Validation
R1	Data unusable – Verification
S	Matrix spike
U	Analyzed, not detected at/above method detection limit
U1	Analyzed, not detect at/above method detection limit – Verification
UJ	Associated value is considered estimated at an elevated detection
UJ1	Estimated at elevated level – Verification
V	No problems with the data – Validation
V1	No problems with the data – Verification
Y	Analytical results in validation process
Z	Validation was not requested or could not be performed

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Table A2.3
V&V Reason Code Definitions

Validation Reason Code	Description
***	Unknown code from RFEDS
1	Holding times were exceeded
2	Holding times were grossly exceeded
3	Initial calibration correlation coefficient <0.995
4	Calibration verification criteria were not met
5	CRDL check sample recovery criteria were not met
6	Incorrect calibration of instrument
7	Analyte values > IDL were found in the blanks
8	Negative bias was indicated in the blanks
9	Interference indicated in the ICP interference check sample
10	Laboratory control sample recovery criteria were not met
11	Duplicate sample precision criteria were not met
12	Predigestion matrix spike criteria were not met (+/- 25 percent)
13	Predigestion matrix spike criteria were not met (<30 percent)
14	Post-digestion matrix spike recovery criteria were not met
15	MSA was required but not performed
16	MSA calibration correlation coefficient <0.995
17	Serial dilution criteria not met
18	Documentation was not provided
19	Calibration verification criteria not met
20	AA duplicate injection precision criteria were not met
21	Reagent blanks exceeded MDA
22	Tracer contamination
23	Improper aliquot size
24	Sample aliquot not taken quantitatively
25	Primary standard had exceeded expiration date
26	No raw data submitted by the laboratory
27	Recovery criteria were not met
28	Duplicate analysis was not performed
29	Verification criteria were not met
30	Replicate precision criteria were not met
31	Replicate analysis was not performed
32	Laboratory control samples >+/- 3 sigma
33	Laboratory control samples >+/- 2 sigma and <+/- 3 sigma
35	Transformed spectral index external ST criteria were not met
36	MDA exceeded the RDL
37	Sample exceeded efficiency curve weight limit
38	Excessive solids on planchet
39	Tune criteria not met
40	Organics initial calibration criteria were not met

Table A2.3
V&V Reason Code Definitions

Validation Reason Code	Description
41	Organics continuing calibration criteria were not met
42	Surrogates were outside criteria
43	Internal standards outside criteria
44	No mass spectra were provided
45	Results were not confirmed
47	Percent breakdown exceeded 20 percent
48	Linear range of instrument was exceeded
49	Method blank contamination
51	Nonverifiable laboratory results and/or unsubmitted data
52	Transcription error
53	Calculation error
54	Incorrect reported activity or MDA
55	Result exceeds linear range; serial dilution value reported
56	IDL changed due to significant figure discrepancy
57	Percent solids < 30 percent
58	Percent solids < 10 percent
59	Blank activity exceeded RDL
60	Blank recovery criteria were not met
61	Replicate recovery criteria were not met
62	LCS relative percent error criteria not met
63	LCS expected value not submitted/verifiable
64	Nontraceable/noncertified standard was used
67	Sample results not submitted/verifiable
68	Frequency of quality control samples not met
69	Samples not distilled
70	Resolution criteria not met
71	Unit conversion of results
72	Calibration counting statistics not met
73	Daily instrument performance assessment not performed
74	LCS data not submitted
75	Blank data not submitted
76	Instrument gain and/or efficiency not submitted
77	Detector efficiency criteria not met
78	MDAs were calculated by reviewer
79	Result obtained through dilution
80	Spurious counts of unknown origin
81	Repeat count outside of 3 sigma counting error
82	Sample results were not corrected for decay
83	Sample results were not included on Data Summary Table
84	Key fields wrong

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Table A2.3
V&V Reason Code Definitions

Validation Reason Code	Description
85	Record added by QLI
86	Results considered qualitative not quantitative
87	Laboratory did no analysis for this record
88	Blank corrected results
89	Sample analysis was not requested
90	Sample result was not validated due to reanalysis
91	Unit conversion; QC sample activity/uncertainty/MDA
99	See hard copy for further explanation
101	Holding times were exceeded (attributed to laboratory problem)
102	Holding times were grossly exceeded (attribute to laboratory problem)
103	Calibration correlation coefficient does not meet requirement
104	Calibration verification recovery criteria were not met
105	Low-level check sample recovery criteria were not met
106	Calibration did not contain minimum number of standards
107	Analyte detected but < RDL in calibration blank verification
109	Interference indicated in the ICP interference check sample
110	Laboratory control sample recovery criteria were not met
111	Laboratory duplicate sample precision criteria were not met
112	Predigestion matrix spike criteria were not met (+/- 25 percent)
113	Predigestion matrix spike recovery is <30 percent
114	Post-digestion matrix spike criteria were not met
115	MSA was required but not performed
116	MSA calibration correlation coefficient <0.995
117	Serial dilution percent D criteria not met
123	Improper aliquot size
128	Laboratory duplicate was not analyzed
129	Verification criteria for frequency or sequence were not met
130	Replicate precision criteria were not met
131	Confirmation percent difference criteria not met
132	Laboratory control samples >+/- 3 sigma
136	MDA exceeded the RDL
139	Tune criteria not met
140	Requirements for independent calibration verification were not met
141	Continuing calibration verification criteria were not met
142	Surrogates were outside criteria
143	Internal standards outside criteria
145	Results were not confirmed
147	Percent breakdown exceeded 20 percent
148	Linear range of measurement system was exceeded
149	Method, preparation, or reagent blank contamination > RDL

Table A2.3
V&V Reason Code Definitions

Validation Reason Code	Description
150	Unknown carrier volume
152	Reported data do not agree with raw data
153	Calculation error
155	Original result exceeds linear range; serial dilution value reported
159	Magnitude of calibration verification blank result exceeded the RDL
164	Standard traceability or certification requirements not met
166	Carrier aliquot nonverifiable
168	QC sample frequency does not meet requirements
170	Resolution criteria not met
172	Calibration counting statistics not met
174	LCS data not submitted
175	Blank data not submitted
177	Detector efficiency criteria not met
188	Blank corrected results
199	See hard copy for further explanation
201	Preservation requirements not met by the laboratory
205	Unobtainable omissions or errors on SDP (required for databases)
206	Analyses were not requested according to the SOW
207	Sample pretreatment or sample preparation method is incorrect
211	Poor cleanup recovery
212	Instrument detection limit was not provided
213	Instrument detection limit is > the associated RDL
214	IDL is older than 3 months from date of analysis
215	Blank results were not reported to the IDL/MDL
216	Post-digestion spike recoveries outside of 85-115 percent criteria
217	Post-digestion spike recoveries were < 10 percent
218	Sample COC was not verifiable (attributed to laboratory)
219	Standards have expired or are not valid
220	TCLP sample percent solids < 0.5 percent
222	TCLP particle size was not performed
224	Incomplete TCLP extraction data
225	Insufficient TCLP extraction time
226	TIC misidentification
227	No documentation regarding deviations from methods or SOW
228	Calibration recoveries affecting data quality have not been met
229	Element not analyzed in ICP interference check sample
230	QC sample/analyte (e.g., spike, duplicate, LCS) not analyzed
231	MS/MSD criteria not met
232	Control limits not assigned correctly
233	Sample matrix QC does not represent samples analyzed

Table A2.3
V&V Reason Code Definitions

Validation Reason Code	Description
234	QC sample does not meet method requirement
235	Duplicate sample control limits do not pass
236	LCS control limits do not pass
237	Preparation blank control limits do not pass
238	Blank correction was not performed
239	Winsorized mean plus standard deviation of the same not calculated or calculated wrong
240	Sample preparations for soil/sludge/sediment were not homog/aliq properly
241	No micro PPT or electroplating data available
242	Tracer requirements were not met
243	Standard values were not calculated correctly (LCS, tracer, standards)
244	Standard or tracer is not NIST traceable
245	Energy calibration criteria not met
246	Background calibration criteria were not met
247	Sample or control analysis not chemically separated from each other
248	Single combined TCLP result was not repeated for sample with both mis+nonm
249	Result qualified due to blank contamination
250	Incorrect analysis sequence
251	Misidentified target compounds
252	Result is suspect DU
701	Holding times were exceeded (not attributed to laboratory)
702	Holding times were grossly exceeded (not attributed to laboratory)
703	Samples were not preserved properly in the field (not attributed to laboratory)
801	Missing deliverables (required for data assessment)
802	Missing deliverables (not required for data assessment)
803	Omissions or errors on SDP deliverables (required for data assessment)
804	Omissions or errors on SDP deliverables (not required for data assessment
805	Information missing from case narrative
806	Site samples not used for sample matrix QC
807	Original documentation not provided
808	Incorrect or incomplete DRC
809	Non-site samples reported with site samples
810	EDD does not match hard copy; EDD may be resubmitted

Table A2.4

Standardized V&V Reason Code Definitions, QC Categories, and Affected PARCC Parameters

Validation Reason Codes	Standardized Description	QC Category	Affected PARCC Parameter
188, 88	Blank corrected results	Blanks	Representativeness
238	Blank correction was not performed	Blanks	Representativeness
175, 75	Blank data not submitted	Blanks	Representativeness
60	Blank recovery criteria were not met	Blanks	Representativeness
215	Blank results were not reported to the IDL/MDL	Blanks	Representativeness
107, 159	Calibration verification blank contamination	Blanks	Representativeness
149, 21, 237, 249, 49, 59, 7	Method, preparation, or reagent blank contamination	Blanks	Representativeness
8	Negative bias indicated in the blanks	Blanks	Representativeness
153, 53	Calculation error	Calculation Errors	Other
232	Control limits not assigned correctly	Calculation Errors	Other
246	Background calibration criteria were not met	Calibration	Accuracy
103, 3	Calibration correlation coefficient did not meet requirements	Calibration	Accuracy
172, 72	Calibration counting statistics did not meet criteria	Calibration	Accuracy
106	Calibration did not contain minimum number of standards	Calibration	Accuracy
228	Calibration requirements affecting data quality have not been met	Calibration	Accuracy
104, 141, 19, 29, 4, 40, 41	Continuing calibration verification criteria were not met	Calibration	Accuracy
245	Energy calibration criteria not met	Calibration	Accuracy
6	Incorrect calibration of instrument	Calibration	Accuracy
148, 48	Result exceeded linear range of measurement system	Calibration	Accuracy
155, 55	Original result exceeded linear range, serial dilution value reported	Calibration	Accuracy
140	Requirements for independent calibration verification were not met	Calibration	Accuracy
129	Frequency or sequencing verification criteria not met	Calibration	Accuracy
131	Confirmation percent difference criteria not met	Confirmation	Precision
145, 45	Results were not confirmed	Confirmation	Precision
18	Sufficient documentation not provided by the laboratory	Documentation issues	Representativeness
705	Electronic qualifiers were applied from validation report by hand	Documentation issues	Other
805	Information missing from case narrative	Documentation issues	Other
84	Key data field incorrect	Documentation issues	Other
802	Missing deliverables (not required for validation)	Documentation issues	Other
801	Missing deliverables (required for validation)	Documentation issues	Representativeness
227	No documentation regarding deviations from methods or SOW	Documentation issues	Other
44	No mass spectra were provided	Documentation issues	Representativeness
241	No micro pipette or electroplating data available	Documentation issues	Other
26	No raw data submitted by the laboratory	Documentation issues	Representativeness

Table A2.4

Standardized V&V Reason Code Definitions, QC Categories, and Affected PARCC Parameters

Validation Reason Codes	Standardized Description	QC Category	Affected PARCC Parameter
804	Omissions or errors in SDP (not required for validation)	Documentation issues	Other
803	Omissions or errors in SDP (required for validation)	Documentation issues	Representativeness
807	Original documentation not provided	Documentation issues	Other
85	Record added by the validator	Documentation issues	Other
152	Reported data do not agree with raw data	Documentation issues	Other
89	Sample analysis was not requested	Documentation issues	Other
218	Sample COC was not verifiable (attributed to laboratory)	Documentation issues	Representativeness
704	Sample COC was not verifiable (not attributed to laboratory)	Documentation issues	Representativeness
83.	Sample results were not included on Data Summary Table	Documentation issues	Other
52	Transcription error	Documentation issues	Other
205	Unobtainable omissions or errors on SDP (required for data assessment)	Documentation issues	Representativeness
1, 101, 701	Holding times were exceeded	Holding times	Representativeness
2, 102, 702	Holding times were grossly exceeded	Holding times	Representativeness
251	Misidentified target compounds	Identification errors	Representativeness
70	Resolution criteria not met	Identification errors	Representativeness
226	TIC misidentification	Identification errors	Representativeness
143, 43	Internal standards did not meet criteria	Internal standards	Accuracy
5	CRDL check sample recovery criteria were not met	LCS	Accuracy
33	LCS > ± 2 sigma and < ± 3 sigma	LCS	Accuracy
10, 110, 236	LCS recovery criteria were not met	LCS	Accuracy
132, 32	Laboratory control samples > ± 3 sigma	LCS	Accuracy
174, 74	LCS data not submitted	LCS	Representativeness
63	Expected LCS value not submitted/verifiable	LCS	Representativeness
62	LCS relative percent error criteria not met	LCS	Accuracy
105	Low-level check sample recovery criteria were not met	LCS	Accuracy
230	QC sample/analyte (e.g., spike, duplicate, LCS) not analyzed	LCS	Representativeness
28	Duplicate analysis was not performed	Matrices	Precision
11, 235	Duplicate sample precision criteria were not met	Matrices	Precision
111	LCS/LCSD precision criteria were not met	Matrices	Precision
128	Laboratory duplicate was not analyzed	Matrices	Precision
231	MS/MSD criteria not met	Matrices	Precision
116, 16	MSA calibration correlation coefficient <0.995	Matrices	Accuracy
115, 15	MSA was required but not performed	Matrices	Representativeness
58	Sample contained < 10 percent solid material	Matrices	Representativeness
57	Sample contained < 30 percent solid material	Matrices	Representativeness
217	Post-digestion spike recoveries were < 10%	Matrices	Accuracy
14, 114, 216	Post-digestion matrix spike criteria were not met	Matrices	Accuracy
113, 13	Predigestion matrix spike recovery is <30%	Matrices	Accuracy

Table A2.4

Standardized V&V Reason Code Definitions, QC Categories, and Affected PARCC Parameters

Validation Reason Codes	Standardized Description	QC Category	Affected PARCC Parameter
112, 12	Predigestion matrix spike recovery criteria were not met	Matrices	Accuracy
27	Recovery criteria were not met	Matrices	Accuracy
31	Replicate analysis was not performed	Matrices	Precision
130, 30	Replicate precision criteria were not met	Matrices	Precision
61	Replicate recovery criteria were not met	Matrices	Accuracy
233	Sample matrix QC does not represent samples analyzed	Matrices	Representativeness
117, 17	Serial dilution criteria not met	Matrices	Accuracy
806	Site samples not used for sample matrix QC	Matrices	Representativeness
810	EDD does not match hard copy; EDD may be resubmitted	Other	Other
214	IDL is older than 3 months from date of analysis	Other	Accuracy
250	Incorrect analysis sequence	Other	Representativeness
808	Incorrect or incomplete DRC	Other	Representativeness
212	Instrument detection limit was not provided	Other	Other
87	Laboratory did no analysis for this record	Other	Other
809	Nonsite samples reported with Site samples	Other	Other
64	Nontraceable/noncertified standard was used	Other	Accuracy
51	Nonverifiable laboratory results and/or unsubmitted data	Other	Representativeness
211	Poor cleanup recovery	Other	Accuracy
25	Primary standard had exceeded expiration date	Other	Accuracy
234	QC sample does not meet method requirement	Other	Representativeness
168, 68	QC sample frequency does not meet requirements	Other	Representativeness
252	Result is suspect due to dilution	Other	Other
79	Result obtained through dilution	Other	Other
37	Sample exceeded efficiency curve weight limit	Other	Accuracy
247	Sample or control analyses not chemically separated from each other	Other	Representativeness
90	Sample result was not validated due to re-analysis	Other	Other
67	Sample results not submitted/verifiable	Other	Representativeness
199, 99	See hard copy for further explanation	Other	Other
248	Single combined TCLP results was not reported for sample with both mis+nonm	Other	Accuracy
80	Spurious counts of unknown origin	Other	Representativeness
244	Standard or tracer is not NIST traceable	Other	Accuracy
164	Standard traceability or certification requirements not met	Other	Accuracy
219	Standards have expired or are not valid	Other	Accuracy
243	Standard values were not calculated correctly (LCS, tracer, standards)	Other	Other
22	Tracer contamination	Other	Accuracy
242	Tracer requirements were not met	Other	Accuracy
71	Unit conversion of results	Other	Other

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Table A2.4

Standardized V&V Reason Code Definitions, QC Categories, and Affected PARCC Parameters

Validation Reason Codes	Standardized Description	QC Category	Affected PARCC Parameter
239	Winsorized mean+standard deviation of the same not calculated or calculated wrong	Other	Other
38	Excessive solids on planchet	Sample preparation	Accuracy
123, 23	Improper aliquot size	Sample preparation	Accuracy
224	Incomplete TCLP extraction data	Sample preparation	Representativeness
225	Insufficient TCLP extraction time	Sample preparation	Representativeness
201	Preservation requirements not met by the laboratory	Sample preparation	Representativeness
24	Sample aliquot not taken quantitatively	Sample preparation	Accuracy
240	Sample preparation for soil/sludge/ sediment were not homog/aliq properly	Sample preparation	Representativeness
207	Sample pretreatment or preparation method is incorrect	Sample preparation	Representativeness
69	Samples not distilled	Sample preparation	Representativeness
703	Samples were not preserved properly in the field	Sample preparation	Representativeness
222	TCLP particle size was not performed	Sample preparation	Representativeness
220	TCLP sample percent solids < 0.5 percent	Sample preparation	Representativeness
56	IDL changed due to significant figure discrepancy	Sensitivity	Representativeness
54	Incorrect reported activity or MDA	Sensitivity	Other
213	Instrument detection limit > the associated RDL	Sensitivity	Representativeness
136, 36	MDA exceeded the RDL	Sensitivity	Representativeness
78	MDA was calculated by reviewer	Sensitivity	Other
81	Repeat count outside of 3 sigma counting error	Sensitivity	Precision
86	Results considered qualitative not quantitative	Sensitivity	Accuracy
82	Sample results were not corrected for decay	Sensitivity	Other
91	Unit conversion, QC sample activity uncertainty/MDA	Sensitivity	Representativeness
142, 42	Surrogates were outside criteria	Surrogate	Accuracy
20	AA duplicate injection precision criteria were not met	Instrument Set-up	Precision
73	Daily instrument performance assessment not performed	Instrument Set-up	Accuracy
177, 77	Detector efficiency criteria not met	Instrument Set-up	Accuracy
229	Element not analyzed in ICP interference check sample	Instrument Set-up	Representativeness
76	Instrument gain and/or efficiency not submitted	Instrument Set-up	Representativeness
109, 9	Interference indicated in the ICP interference check sample	Instrument Set-up	Accuracy
147, 47	Percent breakdown exceeded 20 percent	Instrument Set-up	Representativeness
170	Resolution criteria not met	Instrument Set-up	Representativeness
35	Transformed spectral index external site criteria were not met	Instrument Set-up	Representativeness
139, 39	Tune criteria not met	Instrument Set-up	Accuracy
206	Analysis was not requested according to SOW	Unknown	Other
166	Carrier aliquot nonverifiable	Unknown	Representativeness
150	Unknown carrier volume	Unknown	Representativeness

Table A2.5
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Herbicide	SOIL	Holding Times	Holding times were exceeded	No	3	25	12.00
Metal	SOIL	Blanks	Calibration verification blank contamination	No	37	1,707	2.17
Metal	SOIL	Blanks	Calibration verification blank contamination	Yes	23	1,707	1.35
Metal	SOIL	Blanks	Method, preparation, or reagent blank contamination	No	22	1,707	1.29
Metal	SOIL	Blanks	Method, preparation, or reagent blank contamination	Yes	22	1,707	1.29
Metal	SOIL	Blanks	Negative bias indicated in the blanks	No	6	1,707	0.35
Metal	SOIL	Blanks	Negative bias indicated in the blanks	Yes	14	1,707	0.82
Metal	SOIL	Calibration	Calibration correlation coefficient did not meet requirements	Yes	1	1,707	0.06
Metal	SOIL	Documentation Issues	Key data fields incorrect	No	7	1,707	0.41
Metal	SOIL	Documentation Issues	Key data fields incorrect	Yes	4	1,707	0.23
Metal	SOIL	Documentation Issues	Transcription error	Yes	13	1,707	0.76
Metal	SOIL	Instrument Set-up	Interference was indicated in the interference check sample	No	5	1,707	0.29
Metal	SOIL	Instrument Set-up	Interference was indicated in the interference check sample	Yes	8	1,707	0.47
Metal	SOIL	LCS	CRDL check sample recovery criteria were not met	No	17	1,707	1.00
Metal	SOIL	LCS	CRDL check sample recovery criteria were not met	Yes	28	1,707	1.64
Metal	SOIL	LCS	LCS recovery criteria were not met	No	67	1,707	3.93
Metal	SOIL	LCS	LCS recovery criteria were not met	Yes	215	1,707	12.60
Metal	SOIL	LCS	Low level check sample recovery criteria were not met	No	42	1,707	2.46
Metal	SOIL	LCS	Low level check sample recovery criteria were not met	Yes	27	1,707	1.58
Metal	SOIL	Matrices	Duplicate sample precision criteria were not met	No	6	1,707	0.35
Metal	SOIL	Matrices	Duplicate sample precision criteria were not met	Yes	65	1,707	3.81
Metal	SOIL	Matrices	LCS/LCSD precision criteria were not met	Yes	17	1,707	1.00
Metal	SOIL	Matrices	MSA calibration correlation coefficient < 0.995	Yes	1	1,707	0.06
Metal	SOIL	Matrices	Percent solids < 30 percent	Yes	48	1,707	2.81
Metal	SOIL	Matrices	Post-digestion MS did not meet control criteria	No	11	1,707	0.64
Metal	SOIL	Matrices	Post-digestion MS did not meet control criteria	Yes	10	1,707	0.59
Metal	SOIL	Matrices	Predigestion MS recovery criteria were not met	No	85	1,707	4.98
Metal	SOIL	Matrices	Predigestion MS recovery criteria were not met	Yes	138	1,707	8.08
Metal	SOIL	Matrices	Predigestion MS recovery was < 30 percent	Yes	13	1,707	0.76
Metal	SOIL	Matrices	Serial dilution criteria were not met	Yes	51	1,707	2.99
Metal	SOIL	Other	IDL is older than 3 months from date of analysis	No	93	1,707	5.45
Metal	SOIL	Other	IDL is older than 3 months from date of analysis	Yes	351	1,707	20.56

Q3

Table A2.5
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Metal	SOIL	Other	Result obtained through dilution	Yes	1	1,707	0.06
Metal	SOIL	Other	See hard copy for further explanation	No	15	1,707	0.88
Metal	SOIL	Other	See hard copy for further explanation	Yes	72	1,707	4.22
Metal	WATER	Blanks	Calibration verification blank contamination	No	99	4,652	2.13
Metal	WATER	Blanks	Calibration verification blank contamination	Yes	15	4,652	0.32
Metal	WATER	Blanks	Method, preparation, or reagent blank contamination	No	257	4,652	5.52
Metal	WATER	Blanks	Method, preparation, or reagent blank contamination	Yes	132	4,652	2.84
Metal	WATER	Blanks	Negative bias indicated in the blanks	No	100	4,652	2.15
Metal	WATER	Blanks	Negative bias indicated in the blanks	Yes	40	4,652	0.86
Metal	WATER	Calculation Errors	Control limits not assigned correctly	Yes	1	4,652	0.02
Metal	WATER	Calibration	Calibration correlation coefficient did not meet requirements	No	10	4,652	0.21
Metal	WATER	Calibration	Calibration correlation coefficient did not meet requirements	Yes	4	4,652	0.09
Metal	WATER	Calibration	Continuing calibration verification criteria were not met	Yes	5	4,652	0.11
Metal	WATER	Calibration	Frequency or sequencing verification criteria not met	No	12	4,652	0.26
Metal	WATER	Calibration	Frequency or sequencing verification criteria not met	Yes	15	4,652	0.32
Metal	WATER	Documentation Issues	Key data fields incorrect	No	20	4,652	0.43
Metal	WATER	Documentation Issues	Key data fields incorrect	Yes	36	4,652	0.77
Metal	WATER	Documentation Issues	Missing deliverables (not required for validation)	No	23	4,652	0.49
Metal	WATER	Documentation Issues	Missing deliverables (not required for validation)	Yes	33	4,652	0.71
Metal	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	No	24	4,652	0.52
Metal	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	57	4,652	1.23
Metal	WATER	Documentation Issues	Record added by the validator	Yes	1	4,652	0.02
Metal	WATER	Documentation Issues	Transcription error	No	337	4,652	7.24
Metal	WATER	Documentation Issues	Transcription error	Yes	28	4,652	0.60
Metal	WATER	Holding Times	Holding times were exceeded	No	3	4,652	0.06
Metal	WATER	Instrument Set-up	Interference was indicated in the interference check sample	No	2	4,652	0.04
Metal	WATER	Instrument Set-up	Interference was indicated in the interference check sample	Yes	5	4,652	0.11
Metal	WATER	LCS	CRDL check sample recovery criteria were not met	No	35	4,652	0.75
Metal	WATER	LCS	CRDL check sample recovery criteria were not met	Yes	33	4,652	0.71
Metal	WATER	LCS	LCS recovery criteria were not met	No	2	4,652	0.04
Metal	WATER	LCS	LCS recovery criteria were not met	Yes	7	4,652	0.15
Metal	WATER	LCS	Low level check sample recovery criteria were not met	No	26	4,652	0.56

Table A2.5
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Metal	WATER	LCS	Low level check sample recovery criteria were not met	Yes	18	4,652	0.39
Metal	WATER	LCS	QC sample/analyte (e.g. spike, duplicate, LCS) was not analyzed	No	11	4,652	0.24
Metal	WATER	LCS	QC sample/analyte (e.g. spike, duplicate, LCS) was not analyzed	Yes	15	4,652	0.32
Metal	WATER	Matrices	Duplicate sample precision criteria were not met	No	7	4,652	0.15
Metal	WATER	Matrices	Duplicate sample precision criteria were not met	Yes	32	4,652	0.69
Metal	WATER	Matrices	LCS/LCSD precision criteria were not met	No	4	4,652	0.09
Metal	WATER	Matrices	LCS/LCSD precision criteria were not met	Yes	3	4,652	0.06
Metal	WATER	Matrices	Post-digestion MS did not meet control criteria	No	35	4,652	0.75
Metal	WATER	Matrices	Post-digestion MS did not meet control criteria	Yes	9	4,652	0.19
Metal	WATER	Matrices	Predigestion MS recovery criteria were not met	No	56	4,652	1.20
Metal	WATER	Matrices	Predigestion MS recovery criteria were not met	Yes	68	4,652	1.46
Metal	WATER	Matrices	Predigestion MS recovery was < 30 percent	No	1	4,652	0.02
Metal	WATER	Matrices	Serial dilution criteria were not met	No	1	4,652	0.02
Metal	WATER	Matrices	Serial dilution criteria were not met	Yes	76	4,652	1.63
Metal	WATER	Other	IDL is older than 3 months from date of analysis	No	78	4,652	1.68
Metal	WATER	Other	IDL is older than 3 months from date of analysis	Yes	58	4,652	1.25
Metal	WATER	Other	See hard copy for further explanation	Yes	1	4,652	0.02
Metal	WATER	Sample Preparation	Samples were not properly preserved in the field	No	24	4,652	0.52
Metal	WATER	Sample Preparation	Samples were not properly preserved in the field	Yes	31	4,652	0.67
Metal	WATER	Sensitivity	IDL changed due to a significant figure discrepancy	No	25	4,652	0.54
PCB	SOIL	Documentation Issues	Transcription error	No	63	175	36.00
PCB	SOIL	Holding Times	Holding times were exceeded	No	21	175	12.00
PCB	SOIL	Other	See hard copy for further explanation	No	7	175	4.00
PCB	SOIL	Surrogates	Surrogate recovery criteria were not met	No	14	175	8.00
Pesticide	SOIL	Documentation Issues	Transcription error	No	8	529	1.51
Pesticide	SOIL	Holding Times	Holding times were exceeded	No	63	529	11.91
Pesticide	SOIL	Other	See hard copy for further explanation	No	20	529	3.78
Pesticide	SOIL	Surrogates	Surrogate recovery criteria were not met	No	40	529	7.56
Radionuclide	SOIL	Blanks	Blank recovery criteria were not met	Yes	2	441	0.45
Radionuclide	SOIL	Blanks	Method, preparation, or reagent blank contamination	No	2	441	0.45
Radionuclide	SOIL	Blanks	Method, preparation, or reagent blank contamination	Yes	35	441	7.94
Radionuclide	SOIL	Calculation Errors	Calculation error	Yes	4	441	0.91

Table A2.5
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Radionuclide	SOIL	Calibration	Continuing calibration verification criteria were not met	Yes	48	441	10.88
Radionuclide	SOIL	Documentation Issues	Record added by the validator	Yes	3	441	0.68
Radionuclide	SOIL	Documentation Issues	Results were not included on Data Summary Table	Yes	1	441	0.23
Radionuclide	SOIL	Documentation Issues	Sufficient documentation not provided by the laboratory	No	2	441	0.45
Radionuclide	SOIL	Documentation Issues	Sufficient documentation not provided by the laboratory	Yes	52	441	11.79
Radionuclide	SOIL	Documentation Issues	Transcription error	No	2	441	0.45
Radionuclide	SOIL	Documentation Issues	Transcription error	Yes	55	441	12.47
Radionuclide	SOIL	Holding Times	Holding times were grossly exceeded	Yes	6	441	1.36
Radionuclide	SOIL	Instrument Set-up	Detector efficiency did not meet requirements	Yes	8	441	1.81
Radionuclide	SOIL	Instrument Set-up	Resolution criteria were not met	Yes	4	441	0.91
Radionuclide	SOIL	LCS	LCS recovery > +/- 3 sigma	Yes	18	441	4.08
Radionuclide	SOIL	LCS	LCS recovery criteria were not met	Yes	4	441	0.91
Radionuclide	SOIL	LCS	LCS relative percent error criteria not met	No	1	441	0.23
Radionuclide	SOIL	LCS	LCS relative percent error criteria not met	Yes	11	441	2.49
Radionuclide	SOIL	Matrices	Recovery criteria were not met	Yes	1	441	0.23
Radionuclide	SOIL	Matrices	Replicate analysis was not performed	Yes	1	441	0.23
Radionuclide	SOIL	Matrices	Replicate precision criteria were not met	Yes	5	441	1.13
Radionuclide	SOIL	Other	Lab results not verified due to unsubmitted data	Yes	6	441	1.36
Radionuclide	SOIL	Other	QC sample does not meet method requirements	No	22	441	4.99
Radionuclide	SOIL	Other	QC sample does not meet method requirements	Yes	18	441	4.08
Radionuclide	SOIL	Other	Sample exceeded efficiency curve weight limit	Yes	9	441	2.04
Radionuclide	SOIL	Other	See hard copy for further explanation	No	1	441	0.23
Radionuclide	SOIL	Other	See hard copy for further explanation	Yes	25	441	5.67
Radionuclide	SOIL	Sensitivity	Incorrect reported activity or MDA	No	1	441	0.23
Radionuclide	SOIL	Sensitivity	MDA exceeded the RDL	No	3	441	0.68
Radionuclide	SOIL	Sensitivity	MDA exceeded the RDL	Yes	4	441	0.91
Radionuclide	SOIL	Sensitivity	MDA was calculated by reviewer	Yes	149	441	33.79
Radionuclide	SOIL	Sensitivity	Results considered qualitative not quantitative	Yes	3	441	0.68
Radionuclide	WATER	Blanks	Blank recovery criteria were not met	No	3	701	0.43
Radionuclide	WATER	Blanks	Method, preparation, or reagent blank contamination	No	8	701	1.14
Radionuclide	WATER	Blanks	Method, preparation, or reagent blank contamination	Yes	58	701	8.27
Radionuclide	WATER	Calculation Errors	Calculation error	Yes	1	701	0.14

Table A2.5
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Radionuclide	WATER	Calibration	Calibration counting statistics did not meet criteria	No	2	701	0.29
Radionuclide	WATER	Calibration	Continuing calibration verification criteria were not met	No	20	701	2.85
Radionuclide	WATER	Calibration	Continuing calibration verification criteria were not met	Yes	121	701	17.26
Radionuclide	WATER	Documentation Issues	Missing deliverables (required for validation)	No	1	701	0.14
Radionuclide	WATER	Documentation Issues	Missing deliverables (required for validation)	Yes	1	701	0.14
Radionuclide	WATER	Documentation Issues	No raw data submitted by the laboratory	Yes	1	701	0.14
Radionuclide	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	3	701	0.43
Radionuclide	WATER	Documentation Issues	Record added by the validator	Yes	18	701	2.57
Radionuclide	WATER	Documentation Issues	Sufficient documentation not provided by the laboratory	Yes	128	701	18.26
Radionuclide	WATER	Documentation Issues	Transcription error	No	72	701	10.27
Radionuclide	WATER	Documentation Issues	Transcription error	Yes	52	701	7.42
Radionuclide	WATER	Holding Times	Holding times were exceeded	No	7	701	1.00
Radionuclide	WATER	Holding Times	Holding times were exceeded	Yes	9	701	1.28
Radionuclide	WATER	Holding Times	Holding times were grossly exceeded	No	2	701	0.29
Radionuclide	WATER	Instrument Set-up	Resolution criteria were not met	No	1	701	0.14
Radionuclide	WATER	Instrument Set-up	Resolution criteria were not met	Yes	4	701	0.57
Radionuclide	WATER	Instrument Set-up	Transformed spectral index external site criteria were not met	No	6	701	0.86
Radionuclide	WATER	LCS	Expected LCS value not submitted/verifiable	No	5	701	0.71
Radionuclide	WATER	LCS	Expected LCS value not submitted/verifiable	Yes	12	701	1.71
Radionuclide	WATER	LCS	LCS recovery > +/- 3 sigma	No	26	701	3.71
Radionuclide	WATER	LCS	LCS recovery > +/- 3 sigma	Yes	39	701	5.56
Radionuclide	WATER	LCS	LCS recovery criteria were not met	No	3	701	0.43
Radionuclide	WATER	LCS	LCS recovery criteria were not met	Yes	3	701	0.43
Radionuclide	WATER	LCS	LCS relative percent error criteria not met	No	12	701	1.71
Radionuclide	WATER	LCS	LCS relative percent error criteria not met	Yes	46	701	6.56
Radionuclide	WATER	Matrices	Recovery criteria were not met	No	1	701	0.14
Radionuclide	WATER	Matrices	Recovery criteria were not met	Yes	14	701	2.00
Radionuclide	WATER	Matrices	Replicate analysis was not performed	No	7	701	1.00
Radionuclide	WATER	Matrices	Replicate analysis was not performed	Yes	17	701	2.43
Radionuclide	WATER	Matrices	Replicate precision criteria were not met	No	15	701	2.14
Radionuclide	WATER	Matrices	Replicate precision criteria were not met	Yes	52	701	7.42
Radionuclide	WATER	Matrices	Replicate recovery criteria were not met	No	2	701	0.29

Table A2.5
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Radionuclide	WATER	Matrices	Replicate recovery criteria were not met	Yes	7	701	1.00
Radionuclide	WATER	Other	Lab results not verified due to unsubmitted data	No	1	701	0.14
Radionuclide	WATER	Other	Lab results not verified due to unsubmitted data	Yes	9	701	1.28
Radionuclide	WATER	Other	Sample exceeded efficiency curve weight limit	Yes	4	701	0.57
Radionuclide	WATER	Other	Sample results were not validated due to re-analysis	No	1	701	0.14
Radionuclide	WATER	Other	Sample results were not validated due to re-analysis	Yes	2	701	0.29
Radionuclide	WATER	Other	See hard copy for further explanation	No	9	701	1.28
Radionuclide	WATER	Other	See hard copy for further explanation	Yes	65	701	9.27
Radionuclide	WATER	Sample Preparation	Improper aliquot size	Yes	1	701	0.14
Radionuclide	WATER	Sensitivity	Incorrect reported activity or MDA	Yes	2	701	0.29
Radionuclide	WATER	Sensitivity	MDA exceeded the RDL	No	10	701	1.43
Radionuclide	WATER	Sensitivity	MDA exceeded the RDL	Yes	33	701	4.71
Radionuclide	WATER	Sensitivity	MDA was calculated by reviewer	Yes	297	701	42.37
Radionuclide	WATER	Sensitivity	Repeat count outside of 3 sigma counting error	Yes	1	701	0.14
SVOC	SOIL	Blanks	Method, preparation, or reagent blank contamination	No	4	1,760	0.23
SVOC	SOIL	Calibration	Continuing calibration verification criteria were not met	No	10	1,760	0.57
SVOC	SOIL	Calibration	Continuing calibration verification criteria were not met	Yes	2	1,760	0.11
SVOC	SOIL	Holding Times	Holding times were exceeded	No	177	1,760	10.06
SVOC	SOIL	Internal Standards	Internal standards did not meet criteria	No	15	1,760	0.85
SVOC	SOIL	Internal Standards	Internal standards did not meet criteria	Yes	5	1,760	0.28
SVOC	SOIL	Matrices	Percent solids < 30 percent	Yes	3	1,760	0.17
SVOC	WATER	Blanks	Method, preparation, or reagent blank contamination	Yes	1	148	0.68
SVOC	WATER	Calibration	Continuing calibration verification criteria were not met	No	2	148	1.35
VOC	SOIL	Blanks	Method, preparation, or reagent blank contamination	No	16	769	2.08
VOC	SOIL	Calibration	Continuing calibration verification criteria were not met	Yes	11	769	1.43
VOC	SOIL	Documentation Issues	Transcription error	No	12	769	1.56
VOC	SOIL	Documentation Issues	Transcription error	Yes	1	769	0.13
VOC	SOIL	Holding Times	Holding times were exceeded	No	12	769	1.56
VOC	SOIL	Internal Standards	Internal standards did not meet criteria	No	100	769	13.00
VOC	SOIL	Internal Standards	Internal standards did not meet criteria	Yes	8	769	1.04
VOC	SOIL	Matrices	Percent solids < 30 percent	No	1	769	0.13
VOC	SOIL	Matrices	Percent solids < 30 percent	Yes	4	769	0.52

Table A2.5
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
VOC	SOIL	Surrogates	Surrogate recovery criteria were not met	No	1	769	0.13
VOC	SOIL	Surrogates	Surrogate recovery criteria were not met	Yes	2	769	0.26
VOC	WATER	Blanks	Method, preparation, or reagent blank contamination	No	37	3,023	1.22
VOC	WATER	Blanks	Method, preparation, or reagent blank contamination	Yes	1	3,023	0.03
VOC	WATER	Calibration	Continuing calibration verification criteria were not met	No	15	3,023	0.50
VOC	WATER	Calibration	Continuing calibration verification criteria were not met	Yes	2	3,023	0.07
VOC	WATER	Confirmation	Results were not confirmed	No	5	3,023	0.17
VOC	WATER	Documentation Issues	Record added by the validator	No	7	3,023	0.23
VOC	WATER	Documentation Issues	Transcription error	No	341	3,023	11.28
VOC	WATER	Documentation Issues	Transcription error	Yes	1	3,023	0.03
VOC	WATER	Holding Times	Holding times were exceeded	No	29	3,023	0.96
VOC	WATER	Internal Standards	Internal standards did not meet criteria	No	12	3,023	0.40
Wet Chemistry	SOIL	Documentation Issues	Transcription error	No	1	52	1.92
Wet Chemistry	SOIL	Holding Times	Holding times were exceeded	Yes	1	52	1.92
Wet Chemistry	SOIL	Holding Times	Holding times were grossly exceeded	No	1	52	1.92
Wet Chemistry	SOIL	Matrices	Duplicate sample precision criteria were not met	Yes	1	52	1.92
Wet Chemistry	SOIL	Matrices	Percent solids < 30 percent	Yes	2	52	3.85
Wet Chemistry	SOIL	Matrices	Predigestion MS recovery was < 30 percent	Yes	22	52	42.31
Wet Chemistry	SOIL	Matrices	Serial dilution criteria were not met	Yes	2	52	3.85
Wet Chemistry	SOIL	Other	IDL is older than 3 months from date of analysis	Yes	15	52	28.85
Wet Chemistry	WATER	Blanks	Method, preparation, or reagent blank contamination	No	4	599	0.67
Wet Chemistry	WATER	Blanks	Negative bias indicated in the blanks	No	5	599	0.83
Wet Chemistry	WATER	Calibration	Calibration correlation coefficient did not meet requirements	Yes	4	599	0.67
Wet Chemistry	WATER	Calibration	Continuing calibration verification criteria were not met	Yes	1	599	0.17
Wet Chemistry	WATER	Calibration	Original result exceeded linear range, serial dilution value reported	Yes	1	599	0.17
Wet Chemistry	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	7	599	1.17
Wet Chemistry	WATER	Documentation Issues	Transcription error	No	5	599	0.83
Wet Chemistry	WATER	Documentation Issues	Transcription error	Yes	8	599	1.34
Wet Chemistry	WATER	Holding Times	Holding times were exceeded	No	6	599	1.00
Wet Chemistry	WATER	Holding Times	Holding times were exceeded	Yes	5	599	0.83

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Table A2.5
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Wet Chemistry	WATER	Holding Times	Holding times were grossly exceeded	No	7	599	1.17
Wet Chemistry	WATER	Holding Times	Holding times were grossly exceeded	Yes	4	599	0.67
Wet Chemistry	WATER	Matrices	Predigestion MS recovery criteria were not met	No	2	599	0.33
Wet Chemistry	WATER	Matrices	Predigestion MS recovery criteria were not met	Yes	21	599	3.51
Wet Chemistry	WATER	Matrices	Predigestion MS recovery was < 30 percent	Yes	1	599	0.17
Wet Chemistry	WATER	Matrices	Serial dilution criteria were not met	Yes	2	599	0.33
Wet Chemistry	WATER	Matrices	Site samples were not used for sample matrix QC	Yes	1	599	0.17
Wet Chemistry	WATER	Other	IDL is older than 3 months from date of analysis	Yes	3	599	0.50
Wet Chemistry	WATER	Sample Preparation	Samples were not properly preserved in the field	Yes	6	599	1.00

Table A2.6
Summary of Data Rejected During V&V

Analyte Group	Matrix	Total No. of Rejected Records	Total No. of Records	Percent Rejected (%)
Herbicide	SOIL	5	34	14.71
Herbicide	WATER	0	2	0.00
Metal	SOIL	133	3,001	4.43
Metal	WATER	267	7,908	3.38
PCB	SOIL	42	266	15.79
PCB	WATER	0	28	0.00
Pesticide	SOIL	128	799	16.02
Pesticide	WATER	0	82	0.00
Radionuclide	SOIL	120	707	16.97
Radionuclide	WATER	379	1,715	22.10
SVOC	SOIL	258	2,262	11.41
SVOC	WATER	0	148	0.00
VOC	SOIL	242	1,748	13.84
VOC	WATER	122	4,807	2.54
Wet Chemistry	SOIL	2	135	1.48
Wet Chemistry	WATER	39	1,110	3.51
	Total	**1,737**	**24,752**	**7.02%**

Table A2.7
Summary of RPDs/DERs of Field Duplicate Analyte Pairs

Analyte Group	Matrix	No. of Duplicates Failing RPD/DER Criteria	Total No. of Duplicate Pairs	Percent Failure (%)	Field Duplicate Frequency (%)
Herbicide	SOIL	0	5	0.00	20.00
Metal	SOIL	16	259	6.18	14.62
Metal	WATER	15	869	1.73	16.39
Pesticide	SOIL	0	45	0.00	8.18
Radionuclide	SOIL	0	66	0.00	14.04
Radionuclide	WATER	0	187	0.00	22.94
SVOC	SOIL	0	295	0.00	16.67
SVOC	WATER	0	12	0.00	6.42
VOC	SOIL	0	24	0.00	3.08
VOC	WATER	0	682	0.00	17.46
Wet Chemistry	SOIL	0	5	0.00	9.62
Wet Chemistry	WATER	3	113	2.65	16.92

Table A2.8
Summary of Data Estimated or Undetected Due to V&V Determinations

Analyte Group	Matrix	No. of CRA Data Records Qualified	Total No. of V&V CRA Records	Detect?	Percent Qualified (%)
Herbicide	SOIL	3	25	No	12.00
Metal	SOIL	245	1,707	No	14.35
Metal	SOIL	482	1,707	Yes	28.24
Metal	WATER	595	4,652	No	12.79
Metal	WATER	420	4,652	Yes	9.03
PCB	SOIL	35	175	No	20.00
Pesticide	SOIL	103	529	No	19.47
Radionuclide	SOIL	1	441	Yes	0.23
Radionuclide	WATER	1	701	No	0.14
Radionuclide	WATER	13	701	Yes	1.85
SVOC	SOIL	206	1,760	No	11.70
SVOC	WATER	2	148	No	1.35
SVOC	WATER	1	148	Yes	0.68
VOC	SOIL	125	769	No	16.25
VOC	SOIL	12	769	Yes	1.56
VOC	WATER	97	3,023	No	3.21
VOC	WATER	3	3,023	Yes	0.10
Wet Chemistry	SOIL	1	52	No	1.92
Wet Chemistry	SOIL	19	52	Yes	36.54
Wet Chemistry	WATER	22	599	No	3.67
Wet Chemistry	WATER	34	599	Yes	5.68
	Total	**2,420**	**14,639**		**16.53%**

Table A2.9
Summary of Data Qualified as Undetected Due to Blank Contamination

Analyte Group	Matrix	No. of CRA Records Qualified as Undetected	Total No. of CRA Records with Detected Results[a]	Percent Qualified as Undetected
Metal	SOIL	26	1,310	1.98
Metal	WATER	65	2,082	3.12
	Total	**91**	**3,392**	**2.68%**

[a] As determined by the laboratory prior to V&V.

COMPREHENSIVE RISK ASSESSMENT

ROCK CREEK DRAINAGE EXPOSURE UNIT

VOLUME 4: ATTACHMENT 3

Statistical Analyses and Professional Judgment

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ACRONYMS AND ABBREVIATIONS

µg/kg	micrograms per kilogram
CDH	Colorado Department of Health
COC	contaminant of concern
CRA	Comprehensive Risk Assessment
DOE	U.S. Department of Energy
ECOI	ecological contaminant of interest
EcoSSL	Ecological Soil Screening Level
ECOPC	ecological contaminant of potential concern
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ERA	Ecological Risk Assessment
ESL	ecological screening level
EU	Exposure Unit
HQ	hazard quotient
IAEU	Industrial Area Exposure Unit
IHSS	Individual Hazardous Substance Site
MDC	maximum detected concentration
mg/kg	milligrams per kilogram
NCP	National Contingency Plan
NOAEL	no observed adverse effect level
PCOC	potential contaminant of concern
PMJM	Preble's meadow jumping mouse

PRG	preliminary remediation goal
RCEU	Rock Creek Drainage Exposure Unit
RFETS	Rocky Flats Environmental Technology Site
RI/FS	Remedial Investigation/Feasibility Study
tESL	threshold ESL
UCL	upper confidence limit
UTL	upper tolerance limit
WRW	wildlife refuge worker

1.0 INTRODUCTION

This attachment presents the results for the statistical analyses and professional judgment evaluation used to select human health contaminants of concern (COCs) as part of the Human Health Risk Assessment (HHRA) and ecological contaminants of potential concern (ECOPCs) as part of the Ecological Risk Assessment (ERA) for the Rock Creek Drainage Exposure Unit (EU) (RCEU) at the Rocky Flats Environmental Technology Site (RFETS). The methods used to perform the statistical analysis and to develop the professional judgment sections are described in Appendix A, Volume 2, Section 2 of the Resource Conservation and Recovery Act (RCRA) Facility Investigation-Remedial Investigation/Corrective Measures Study (CMS)-Feasibility Study (RI/FS) Report (hereafter referred to as the RI/FS Report) and follow the Final Comprehensive Risk Assessment (CRA) Work Plan and Methodology (DOE 2005).

2.0 RESULTS OF STATISTICAL COMPARISONS TO BACKGROUND FOR THE ROCK CREEK DRAINAGE EXPOSURE UNIT

The results of the statistical background comparisons for inorganic and radionuclide potential contaminants of concern (PCOCs) and ecological contaminants of interest (ECOIs) in surface soil/surface sediment, subsurface soil/subsurface sediment, surface soil, and subsurface soil samples collected from the RCEU are presented in this section. Box plots are provided for analytes that were carried forward into the statistical comparison step and are presented in Figures A3.2.1 to A3.2.17.[1] The box plots display several reference points: 1) the line inside the box is the median; 2) the lower edge of the box is the 25th percentile; 3) the upper edge of the box is the 75th percentile; 4) the upper lines (called whiskers) are drawn to the greatest value that is less than or equal to 1.5 times the inter-quartile range (the interquartile range is between the 75th and 25th percentiles); 5) the lower whiskers are drawn to the lowest value that is greater than or

[1] Statistical background comparisons are not performed for analytes if: 1) the background concentrations are nondetections; 2) background data are unavailable; 3) the analyte has low detection frequency in the RCEU or background data set (less than 20 percent); or 4) the analyte is an organic compound. Box plots are not provided for these analytes. However, these analytes are carried forward into the professional judgment evaluation.

equal to 1.5 times the inter-quartile range; and 6) solid circles are data points greater or less than the whiskers.

ECOIs for surface soil (Preble's meadow jumping mouse [PMJM] receptor) and PCOCs with concentrations in the RCEU that are statistically greater than background (or those where background comparisons were not performed) are carried through to the professional judgment step of the COC/ECOPC selection processes. ECOIs (for non-PMJM receptors) with concentrations in the RCEU that are statistically greater than background (or those where background comparisons were not performed) are carried through to the upper-bound exposure point concentration (EPC) – threshold ecological screening level (tESL) comparison step of the ECOPC selection processes.

PCOCs and ECOIs with concentrations that are not statistically greater than background are not identified as COCs/ECOPCs and are not evaluated further.

2.1 Surface Soil/Surface Sediment Data Used in the HHRA

For the RCEU surface soil/surface sediment data set, the maximum detected concentrations (MDCs) and upper confidence limits on the mean (UCLs) for arsenic, manganese, cesium-134, cesium-137, and radium-228 exceed the wildlife refuge worker (WRW) preliminary remediation goals (PRGs) for the RCEU data set, and these PCOCs were carried forward into the statistical background comparison step. The RCEU MDC for iron exceeds the PRG, but the UCL for the RCEU data set does not exceed the PRG, and this analyte was not evaluated further. The results of the statistical comparison of the RCEU surface soil/surface sediment data to background data for these PCOCs are presented in Table A3.2.1 and the summary statistics for background and RCEU surface soil/surface sediment data are shown in Table A3.2.2. The RCEU MDCs for all other PCOCs do not exceed the PRGs and were not evaluated further.

The results of the statistical comparisons of the RCEU surface soil/surface sediment data to background data indicate the following:

Statistically Greater than Background at the 0.1 Significance Level

- Arsenic
- Manganese
- Cesium-137
- Radium-228

Not Statistically Greater than Background at the 0.1 Significance Level

- Cesium-134

Background Comparison Not Performed[1]

- None

2.2 Subsurface Soil/Subsurface Sediment Data Used in the HHRA

For the RCEU PCOCs in subsurface soil/subsurface sediment, the MDCs and UCLs do not exceed the PRGs. Therefore, no analytes were carried forward into the statistical background comparison step.

2.3 Surface Soil Data Used in the ERA (Non-PMJM)

For the ECOIs in surface soil, the MDCs for aluminum, arsenic, barium, boron, cadmium, chromium, cobalt, copper, lead, lithium, manganese, mercury, molybdenum, nickel, selenium, vanadium, and zinc exceed a non-PMJM ecological screening level (ESL), and these ECOIs were carried forward into the statistical background comparison step. The MDCs for bis(2-ethylhexyl)phthalate and di-n-butylphthalate also exceed a non-PMJM ESL. The results of the statistical comparison of RCEU surface soil data to background data are presented in Table A3.2.3 and the summary statistics for background and RCEU surface soil data are shown in Table A3.2.4.

The results of the statistical comparisons of the RCEU surface soil to background data indicate the following:

Statistically Greater than Background at the 0.1 Significance Level

- Aluminum
- Barium
- Chromium
- Lithium
- Manganese
- Nickel
- Vanadium
- Zinc

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Not Statistically Greater than Background at the 0.1 Significance Level

- Arsenic
- Cadmium
- Cobalt
- Copper
- Lead
- Mercury
- Selenium

Background Comparison not Performed[1]

- Boron
- Molybdenum
- Tin
- Bis(2 ethylhexyl)phthalate
- di-n-butylphthalate

2.4 Surface Soil Data used in the ERA (PMJM)

For the ECOIs in surface soil in PMJM habitat, the MDCs for arsenic, chromium, manganese, molybdenum, nickel, selenium, tin, vanadium, and zinc exceed the PMJM ESLs, and were carried forward into the background comparison step. The results of the statistical comparison of the RCEU surface soil data to background data are presented in Table A3.2.5 and the summary statistics for background and RCEU surface soil data are shown in Table A3.2.6.

The results of the statistical comparisons of the RCEU surface soil in PMJM habitat to background data indicate the following:

Statistically Greater than Background at the 0.1 Significance Level

- Chromium
- Manganese

- Nickel
- Vanadium

Not Statistically Greater than Background at the 0.1 Significance Level

- Arsenic
- Selenium
- Zinc

Background Comparison not Performed[1]

- Molybdenum
- Tin

2.5 Subsurface Soil Data used in the ERA

For the ECOIs in subsurface soil, the MDC for arsenic exceeds the prairie dog ESL and was carried forward into the statistical background comparison step. The MDCs for all other ECOIs do not exceed the prairie dog ESL. The results of the statistical comparison of RCEU subsurface soil data to background data are presented in Table A3.7 and the summary statistics for background and RCEU subsurface soil data are shown in Table A3.8.

The results of the statistical comparisons of the surface soil data to background data indicate the following:

Statistically Greater than Background at the 0.1 Significance Level

- Arsenic

Not Statistically Greater than Background at the 0.1 Significance Level

- None

Background Comparison not Performed[1]

- None

3.0 UPPER-BOUND EXPOSURE POINT CONCENTRATION COMPARISON TO LIMITING ECOLOGICAL SCREENING LEVELS

ECOIs in surface soil and subsurface soil with concentrations that are statistically greater than background, or background comparisons were not performed, are evaluated further by comparing the RCEU EPCs to the tESLs. The EPCs are the 95 percent UCLs of the 90th percentile [upper tolerance limit (UTL)] for small home-range receptors, the UCL for large home-range receptors, or the MDC in the event that the UCL or UTL is greater than the MDC.

3.1 ECOIs in Surface Soil

No ECOIs in surface soil (non-PMJM) were eliminated from further consideration because the EPCs are not greater than the limiting tESLs. Aluminum, barium, boron, chromium, lithium, manganese, molybdenum, nickel, tin, vanadium, and zinc along with two organics (bis(2-ethylhexyl)phthalate and di-n-butylphthalate) have EPCs greater than the limiting tESLs, and these are evaluated in the professional judgment evaluation screening step (Section 4.0).

3.2 ECOIs in Subsurface Soil

No ECOIs in subsurface soil were eliminated from further consideration because the EPCs are not greater than the tESLs. Arsenic has an EPC greater than the limiting tESL and is evaluated in the professional judgment evaluation screening step (Section 4.0).

4.0 PROFESSIONAL JUDGMENT

This section presents the results of the professional judgment step of the COC and ECOPC selection processes for the HHRA and ERA, respectively. Based on the weight of evidence evaluated in the professional judgment step, PCOCs and ECOIs are either included for further evaluation as COCs/ECOPCs in the risk characterization step, or excluded from further evaluation.

The professional judgment evaluation takes into account the following lines of evidence: process knowledge, spatial trends, pattern recognition[2], comparison to RFETS background and regional background data sets (see Table A3.4.1 for a summary of regional background data)[3], and risk potential. For PCOCs or ECOIs where the process knowledge and/or spatial trends indicate that the presence of the analyte in the EU may be a result of historical site-related activities, the professional judgment discussion includes only two of the lines of evidence listed above, and it is concluded that these analytes are COCs/ECOPCs and are carried forward into risk characterization. For the other PCOCs and ECOIs that are evaluated in the professional judgment step, each of the lines of evidence listed above is included in the discussion.

For metals, Appendix A, Volume 2, Attachment 8 of the RI/FS Report provides the details of the process knowledge and spatial trend evaluations. The conclusions from these evaluations are noted in this attachment.

The following PCOCs/ECOIs are evaluated further in the professional judgment step for RCEU:

- Surface soil/surface sediment (HHRA)
  - Arsenic

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[2] The pattern recognition evaluation includes the use of probability plots. If two or more distinct populations are evident in the probability plot, this suggests that one or more local releases may have occurred. Conversely, if only one distinct low-concentration population is defined, likely representing a background population, a local release may or may not have occurred. Similar to all statistical methods, the probability plot has limitations in cases where there is inadequate sampling and the magnitude of the release is relatively small. Thus, absence of two clear populations in the probability plots is consistent with, but not definitive proof of, the hypothesis that no releases have occurred. However, if a release has occurred within the sampled area and has been included in the samples, then the elemental concentrations associated with that release are either within the background concentration range or the entire sampled population represents a release, a highly unlikely probability.

[3] The regional background data set for Colorado and the bordering states was extracted from data for the western United States (Shacklette and Boerngen 1984), and is composed of data from Colorado as well as Arizona, Kansas, Nebraska, New Mexico, Oklahoma, Utah, and Wyoming. Although the background data set for Colorado and the bordering states is not specific to Colorado's Front Range, it is useful for the professional judgment evaluation in the absence of a robust data set for the Front Range. Colorado's Front Range has highly variable terrain that changes elevation over short distances. Consequently, numerous soil types and geologic materials are present at RFETS, and the data set for Colorado and the bordering states may be more representative of these variable soil types.

  - Manganese
  - Cesium-137
  - Radium-228
- Subsurface soil/subsurface sediment (HHRA)
  - No PCOCs were found to be statistically greater than background and above a PRG in accordance with the COC selection process; therefore, no PCOCs in subsurface soil/subsurface sediment are evaluated using professional judgment.
- Surface soil for non-PMJM receptors (ERA)
  - Aluminum
  - Barium
  - Boron
  - Chromium
  - Lithium
  - Manganese
  - Molybdenum
  - Nickel
  - Tin
  - Vanadium
  - Zinc
  - bis(2-Ethylhexyl)phthalate
  - Di-n-butylphthalate
- Surface soil for PMJM receptors (ERA)
  - Chromium
  - Manganese
  - Molybdenum
  - Nickel
  - Tin
  - Vanadium
- Subsurface soil (ERA)
  - Arsenic

The following sections provide the professional judgment evaluations by analyte and medium for the PCOCs/ECOIs listed above.

4.1 Aluminum

Aluminum has an EPC in surface soil (for non-PMJM receptors) greater than the tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine whether aluminum should be retained for risk characterization are summarized below.

4.1.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates a potential for aluminum to have been released into RFETS soil because of the large aluminum metal inventory and presence of aluminum in waste generated during former operations. However, there are no Individual Hazardous Substance Sites (IHSSs) in the RCEU. Therefore aluminum is unlikely to be present in RCEU soil as a result of historical site-related activities.

4.1.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that aluminum concentrations in RCEU surface soil reflect variations in naturally occurring aluminum.

4.1.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for aluminum in surface soil (Figure A3.4.1) suggests the presence of a single population, which is indicative of background conditions.

4.1.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Aluminum concentrations in RCEU surface soil range from 7,420 to 21,800 milligrams per kilogram (mg/kg) with a mean concentration of 14,530 mg/kg and a standard deviation of 3,375 mg/kg. Aluminum concentrations in the background data set range from 4,050 to 17,100 mg/kg, with a mean concentration of 10,203 mg/kg and a standard deviation of 3,256 mg/kg (Table A3.2.4). The concentrations of aluminum in surface soil

samples at the RCEU are slightly elevated compared to background but the data populations overlap considerably.

Aluminum concentrations RCEU surface soil are well within the range for aluminum in soils of Colorado and the bordering states (5,000 to 100,000 mg/kg, with a mean concentration of 50,800 mg/kg and a standard deviation of 23,500 mg/kg) (Table A3.4.1).

4.1.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The MDC for aluminum in the RCEU (21,800 mg/kg) exceeds the no observed adverse effect level (NOAEL) ESL for only one receptor group, terrestrial plants (50 mg/kg). However, U.S. Environmental Protection Agency (EPA) Ecological Soil Screening Level (EcoSSL) guidance (EPA 2003) for aluminum recommends that aluminum should not be considered an ECOPC for soils at sites where the soil pH exceeds 5.5 due to its limited bioavailability in non-acidic soils. The average pH value for RFETS surface soils is 8.2. Therefore, aluminum concentrations in RCEU surface soil are unlikely to result in risk concerns for wildlife populations.

4.1.6 Conclusion

The weight of evidence presented above shows that aluminum concentrations in RCEU surface soil (non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge; a spatial distribution that suggests aluminum is naturally occurring; a probability plot that suggests the presence of a single population which is also indicative of background conditions; RCEU concentrations that are well within regional background levels; and RCEU concentrations that are unlikely to result in risk concerns for wildlife populations. Aluminum is not considered an ECOPC in surface soil for the RCEU and, therefore, is not further evaluated quantitatively.

4.2 Arsenic

Arsenic has concentrations statistically greater than background in surface soil/surface sediment and in subsurface soil and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine whether arsenic should be retained for risk characterization are summarized below.

4.2.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates arsenic is unlikely to be present in RCEU soil as a result of historical site-related activities.

4.2.2 Evaluation of Spatial Trends

Surface Soil/Surface Sediment

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that arsenic concentrations in RCEU surface soil/surface sediment reflect variations in naturally occurring arsenic.

Subsurface Soil

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that arsenic concentrations in RCEU subsurface soil reflect variations in naturally occurring arsenic.

4.2.3 Pattern Recognition

Surface Soil/Surface Sediment

The probability plot for arsenic in surface soil (Figure A3.4.2) suggests the presence of a single population which is indicative of background conditions. Although the highest concentration of arsenic does not fit the distribution of the other data, this single data point does not provide sufficient evidence of a second population.

Subsurface Soil

The probability plot for arsenic in subsurface soil (Figure A3.4.3) suggests the presence of a single population, which is indicative of background conditions.

4.2.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil/Surface Sediment

Arsenic concentrations in RCEU surface soil/surface sediment range from 1.70 to 15.0 mg/kg, with a mean concentration of 5.89 mg/kg and a standard deviation of 2.29 mg/kg. Arsenic concentrations in the background data set range from 0.27 to 9.6 mg/kg, with a mean concentration of 3.42 mg/kg and a standard deviation of 2.55 mg/kg (Table A3.2.2). The range of concentrations of arsenic in the RCEU and background samples overlap considerably with only one detection (9.6 mg/kg) greater than the background MDC.

Arsenic concentrations RCEU surface soil/surface sediment are well within the range for arsenic in soils of Colorado and the bordering states (1.22 to 97 mg/kg, with a mean concentration of 6.9 mg/kg and a standard deviation of 7.64 mg/kg) (Table A3.4.1).

Subsurface Soil

Arsenic concentrations in RCEU subsurface soil range from 2.50 to 13.1 mg/kg, with a mean concentration of 8.08 mg/kg and a standard deviation of 4.07 mg/kg. Arsenic concentrations in the background data set range from 1.70 to 41.8 mg/kg, with a mean concentration of 5.48 mg/kg and a standard deviation of 6.02 mg/kg (Table A3.2.8). The range of arsenic concentrations in the RCEU and background samples overlap considerably, with the background MDC greater than the RCEU MDC.

4.2.5 Risk Potential for HHRA

Surface Soil/Surface Sediment

The arsenic MDC for surface soil/surface sediment is 15.0 mg/kg and the UCL is 6.20 mg/kg. The UCL is less than three times greater than the PRG (2.41 mg/kg), with 45 of the 51 detections greater than the PRG. Because the PRG is based on an excess carcinogenic risk of 1E-06, the cancer risk based on the UCL concentration is less than 3E-06, and is well within the National Contingency Plan (NCP) risk range of 1E-06 to 1E-04. Arsenic was detected in 67 of 73 background samples, and detected concentrations in 39 of the 67 samples exceeded the PRG. The background UCL for arsenic in surface soil/surface sediment is 4.03 mg/kg (Appendix A, Volume 2, Attachment 9 of the RI/FS Report), which equates to a cancer risk of 2E-06. Therefore, the excess cancer risks to the WRW from exposure to arsenic in surface soil/surface sediment in the RCEU is similar to background risk.

4.2.6 Risk Potential for Plants and Wildlife

Subsurface Soil

The MDC and UTL for arsenic in RCEU (13.1 mg/kg) subsurface soil exceed the NOAEL ESL for the prairie dog (9.35 mg/kg). This ESL is less than the MDC for background subsurface soil concentrations. Because risks are not typically expected at background concentrations, this ESL may be overly conservative, and arsenic is unlikely to result in risk concerns for wildlife populations in excess of those likely to be found in background areas.

4.2.7 Conclusion

The weight of evidence presented above shows that arsenic concentrations in RCEU surface soil/surface sediment and subsurface soil are not likely to be a result of historical

site-related activities based on process knowledge; spatial distribution suggests arsenic is naturally occurring; probability plots that suggest the presence of single arsenic data populations which are also indicative of background conditions; RCEU concentrations that are well within regional background levels; and RCEU concentrations that are unlikely to result in risks to humans significantly above background risks. Arsenic is not considered a COC in surface soil/surface sediment or an ECOPC in subsurface soil for the RCEU and, therefore, is not further evaluated quantitatively.

4.3 Barium

Barium has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine whether barium should be retained for risk characterization are summarized below.

4.3.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates barium is unlikely to be present in RFETS soil as a result of historical site-related activities.

4.3.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that barium concentrations in RCEU surface soil reflect variations in naturally occurring barium.

4.3.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for barium in surface soil (Figure A3.4.4) indicates two separate populations: one population extending from 110 to approximately 150 mg/kg, and a second population extending from 160 to 470 mg/kg. Because of the absence of sources in the RCEU, the two populations appear to be different due to background geologic conditions.

4.3.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Barium concentrations in RCEU surface soil range from 110 to 470 mg/kg, with a mean concentration of 168 mg/kg and a standard deviation of 73.9 mg/kg. Barium concentrations in the background data set range from 45.7 to 134 mg/kg, with a mean concentration of 102 and a standard deviation of 19.4 mg/kg (Table A3.2.4). The concentrations of barium in surface soil samples at the RCEU are slightly elevated compared to background, but the data populations do overlap considerably.

Barium concentrations RCEU surface soil are well within the range for barium in soils of Colorado and the bordering states (100 to 3,000 mg/kg, with mean concentration of 642 mg/kg and a standard deviation of 330 mg/kg) (Table A3.4.1).

4.3.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for barium in the RCEU (324 mg/kg) exceeds the NOAEL ESL for the mourning dove herbivore (159 mg/kg) only. The ESL is not below the range of background concentrations and is, therefore, likely to not be overly conservative for use in screening level risk assessments.

4.3.6 Conclusion

The weight of evidence presented above shows that barium concentrations in RCEU surface soil (non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge; a spatial distribution that suggests barium is naturally occurring; and RCEU concentrations that are well within regional background levels. Although there are two data populations present for RCEU surface soil, the absence of historical sources suggests this represents two background geologic conditions. Barium is not considered an ECOPC in surface soil for the RCEU and, therefore, is not further evaluated quantitatively.

4.4 Bis(2-ethylhexyl)phthalate

Bis(2-ethylhexyl)phthalate has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine whether bis(2-ethylhexyl)phthalate should be retained for risk characterization are summarized below.

4.4.1 Summary of Process Knowledge

There are no documented historical source areas present in the RCEU, and no documented operations or activities that occurred in the RCEU involving the use of bis(2-ethylhexyl)phthalate (CDH 1992; DOE 1995; DOE 1992). Therefore, the potential for bis(2-ethylhexyl)phthalate to be present in RCEU surface soil as a result of historical site-related activities is unlikely.

4.4.2 Evaluation of Spatial Trends

Surface Soil (non-PMJM)

Bis(2-ethylhexyl)phthalate was detected in 23.5 percent of the RCEU surface soil samples. The detections are estimated values well below the reported detection limits of 330 to 480 micrograms per kilogram (µg/kg). As shown in Figure A3.4.5, the detections occur randomly throughout the RCEU, and only at one location is the concentration greater than the ESL.

4.4.3 Pattern Recognition

Surface Soil (Non-PMJM)

Bis(2-ethylhexyl)phthalate is not naturally occurring and, therefore, a pattern recognition analysis is not applicable.

4.4.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Bis(2-ethylhexyl)phthalate is not naturally occurring and, therefore, a comparison to background analysis is not applicable.

4.4.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for bis(2-ethylhexyl)phthalate (240 J µg/kg) exceeds the NOAEL ESL for seven ecological receptors (herbivorous mourning dove, insectivorous mourning dove, American kestrel, insectivorous deer mouse, carnivorous coyote, insectivorous coyote, and generalist coyote).

4.4.6 Conclusion

The weight of evidence presented above shows that bis(2-ethylhexyl)phthalate concentrations in RCEU surface soil (non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge. Bis(2-ethylhexyl)phthalate is not considered an ECOPC in surface soil for the RCEU and, therefore, is not further evaluated quantitatively.

4.5 Boron

Boron has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine whether boron should be retained for risk characterization are summarized below.

4.5.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates boron is unlikely to be present in RFETS soil as a result of historical site-related activities.

4.5.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that boron concentrations in RCEU surface soil reflect variations in naturally occurring boron.

4.5.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for the detected boron concentrations suggest a single population, which is indicative of background conditions (Figure A3.4.6).

4.5.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

The reported range for boron in surface soil within Colorado and the bordering states is 20 to 150 mg/kg, with a mean concentration of 27.9 mg/kg and a standard deviation of 19.7 mg/kg (Table A3.4.1). Boron concentrations reported in surface soil samples at the

RCEU is 3.90 to 7.90 mg/kg, with a mean concentration of 5.72 mg/kg and a standard deviation of 1.00 mg/kg (Table A3.2.4). The range of concentrations of boron in surface soil in the RCEU is well within the range for boron in soils of Colorado and the bordering states.

4.5.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for boron in the RCEU (7.7 mg/kg) exceeds the NOAEL ESL for only one receptor group, terrestrial plants (0.5 mg/kg). All other NOAEL ESLs were greater than the UTL and ranged from 30 to 6,070 mg/kg. Site-specific background data for boron were not available, but the MDC did not exceed the low end (20 mg/kg) of the background range presented in Shacklette and Boerngen (1984). This indicates the terrestrial plant NOAEL ESL (0.5 mg/kg) is well below expected background concentrations and, because risks are not typically expected at background concentrations, boron concentrations are not likely to be indicative of site-related risk to the terrestrial plant community in the RCEU. Kabata-Pendias and Pendias (1992) indicate soil with boron concentrations equal to 0.3 mg/kg is critically deficient in boron, and effects on plant reproduction would be expected. Additionally, the summary of boron toxicity in Efroymson et al. (1997) notes that the source of the 0.5-mg/kg NOAEL ESL indicates boron was toxic when added at 0.5 mg/kg to soil, but gives no indication of the boron concentration in the baseline soil before addition. The confidence placed by Efroymson et al. (1997) was low. Because no NOAEL ESLs other than the terrestrial plant NOAEL ESL are exceeded by the MDC, boron is unlikely to present a risk to terrestrial receptor populations in the RCEU.

4.5.6 Conclusion

The weight of evidence presented above shows that boron concentrations in RCEU surface soil (non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge; a spatial distribution that suggests boron is naturally occurring; a probability plot that suggests the presence of a single population which is also indicative of background conditions; RCEU concentrations that are well within regional background levels; and RCEU concentrations that are unlikely to result in risk concerns for wildlife populations. Boron is not considered an ECOPC in surface soil for the RCEU and, therefore, is not further evaluated quantitatively.

4.6 Cesium-137

Cesium-137 has activities statistically greater than background in surface soil/surface sediment and, therefore, was carried forward to the professional judgment step. The lines

of evidence used to determine whether cesium-137 should be retained for risk characterization are summarized below.

4.6.1 Summary of Process Knowledge

The ChemRisk Task 1 Report did not identify cesium-137 as a radionuclide used at RFETS (CDPH 1991a) and no cesium-137 waste was reported to have been generated. It is unlikely that cesium-137 is present in soil at RFETS as a result of historical site-related activities.

4.6.2 Evaluation of Spatial Trends

Surface Soil/Surface Sediment

As shown in Figure A3.4.7, cesium-137 activity exceed the PRG of 0.221 picocuries per gram (pCi/g) at locations throughout the RCEU. There are only two locations where the cesium-137 concentration exceeds the background MDC, and neither is situated near Individual Hazardous Substance Sites (IHSSs) since no historical IHSSs are designated in the RCEU. Thus it appears that cesium-137 activity in RCEU surface soil reflect variations in background levels of this radionuclide.

4.6.3 Pattern Recognition

Surface Soil/Surface Sediment

The probability plot for cesium-137 activity suggests a single population, which is indicative of background conditions (Figure A3.4.8).

4.6.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil/Surface Sediment

Cesium-137 activity in surface soil/surface sediment samples at the RCEU range from 0.103 to 2.50 pCi/g, with a mean concentration of 1.01 pCi/g and a standard deviation of 0.710 pCi/g, while the cesium-137 activities in the background data set range from 0.027 to 1.80 pCi/g, with a mean activity of 0.692 pCi/g and a standard deviation of 0.492 pCi/g (Table A3.2.2). The activities of cesium-137 in surface soil samples at the RCEU are slightly elevated compared to background, but the data populations do overlap considerably.

4.6.5 Risk Potential for HHRA

The cesium-137 PRG for surface soil/surface sediment is 0.221 pCi/g, while the UCL is approximately five times greater, at 1.14 pCi/g. Because the PRG is based on an excess carcinogenic risk of 1E-06, the cancer risk based on the UCL activity is approximately 5E-06, well within the NCP risk range of 1E-06 to 1E-04.

4.6.6 Conclusion

The weight of evidence presented above shows that cesium-137 concentrations in RCEU surface soil/surface sediment are not likely to be a result of historical site-related activities based on process knowledge; a spatial distribution which suggests cesium-137 is at fallout levels; a probability plot that suggests the presence of a single population which is also indicative of fallout levels; and RCEU activities that are unlikely to result in significant risks to humans. Cesium-137 is not considered a COC in surface soil/surface sediment for the RCEU and, therefore, is not further evaluated quantitatively.

4.7 Chromium

Chromium has an EPC in surface soil (for non-PMJM receptors) greater than the tESL and, therefore, was carried forward to the professional judgment step. In addition, chromium in surface soil (for PMJM receptors) has concentrations statistically greater than background. The lines of evidence used to determine whether chromium should be retained for risk characterization are summarized below.

4.7.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates a potential for chromium to have been released into RFETS soil because of the moderate chromium metal inventory and presence of chromium in waste generated during former operations. Spills of chromium-contaminated wastes have also occurred at RFETS. However, there are no IHSSs in the RCEU. Therefore, chromium is unlikely to be present in RCEU soil as a result of historical site-related activities.

4.7.2 Evaluation of Spatial Trends

Surface Soil (non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that chromium concentrations in RCEU surface soil reflect variations in naturally occurring chromium.

Surface Soil (PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that chromium concentrations in RCEU surface soil in PMJM habitat reflect variations in naturally occurring chromium.

4.7.3 Pattern Recognition

Surface Soil (non-PMJM)

The probability plot for chromium suggests a single population, which is indicative of background conditions (Figure A3.4.9).

4.7.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Chromium concentrations in surface soil samples at the RCEU range from 9.00 to 22.0 mg/kg, with a mean concentration of 15.4 mg/kg and a standard deviation of 2.78 mg/kg. Chromium concentrations in the background data set range from 5.50 to 16.9 mg/kg, with a mean concentration of 11.2 mg/kg and a standard deviation of 2.78 mg/kg (Table A3.2.4). The concentrations of chromium in surface soil samples at the RCEU are slightly elevated compared to background, but the data populations do overlap considerably.

Chromium concentrations reported in surface soil samples at the RCEU are well within the range for chromium in soils of Colorado and the bordering states (3 to 500 mg/kg, with mean concentration of 48.2 mg/kg and a standard deviation of 41 mg/kg) (Table A3.4.1).

Surface Soil (PMJM)

Chromium concentrations in surface soil samples in PMJM habitat at the RCEU range from 9.00 to 21.6 mg/kg, with a mean concentration of 15.2 mg/kg and a standard deviation of 2.93 mg/kg. Chromium concentrations in the background data set range from 5.50 to 16.9 mg/kg, with a mean concentration of 11.2 mg/kg and a standard deviation of 2.78 mg/kg (Table A3.2.6). The concentrations of chromium in surface soil samples at the RCEU are slightly elevated compared to background, but the data populations do overlap considerably.

Chromium concentrations reported in surface soil samples at the RCEU are well within the range for chromium in soils of Colorado and the bordering states (3 to 500 mg/kg,

with mean concentration of 48.2 mg/kg and a standard deviation of 41 mg/kg) (Table A3.4.1).

4.7.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for chromium in the RCEU (20.2 mg/kg) exceeds the NOAEL ESL for four receptor groups: terrestrial plants (1 mg/kg), terrestrial invertebrates (0.4 mg/kg), mourning dove insectivore (1.34 mg/kg), and American kestrel (14.0 mg/kg). All other NOAEL ESLs were greater than the UTL and ranged from 24.6 to 4,173 mg/kg. All of these ESLs are less than the MDC in background surface soils. The chromium ESLs are based on toxicity of hexavalent chromium, which is likely to represent only a small fraction of the total chromium detected in soils. The mammalian ESLs for trivalent chromium are considerably greater than the hexavalent chromium ESLs. This indicates that the ESL based on hexavalent chromium may be overly conservative for use in assessing risk to the non-PMJM receptors.

Surface Soil (PMJM)

The MDC for chromium in the RCEU (21.6 mg/kg) exceeds the NOAEL ESL for PMJM (19.3). The chromium ESL is based on toxicity of hexavalent chromium, which is likely to represent only a small fraction of the total chromium detected in soils. The PMJM ESL for trivalent chromium is equal to 16,100 mg/kg. This indicates that the ESL based on hexavalent chromium may be overly conservative for use in assessing risk to the PMJM.

4.7.6 Conclusion

The weight of evidence presented above shows that chromium concentrations in RCEU surface soil (PMJM and non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge; a spatial distribution that suggests chromium is naturally occurring; a probability plot that suggests the presence of a single population which is also indicative of background conditions; and RCEU concentrations that are well within regional background levels. Chromium is not considered an ECOPC in surface soil for the RCEU and, therefore, is not further evaluated quantitatively.

4.8 Di-n-butylphthalate

Di-n-butylphthalate has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine whether di-n-butylphthalate should be retained risk characterization are summarized below.

4.8.1 Summary of Process Knowledge

There are no documented historical source areas present in the RCEU and no documented operations or activities that occurred in RCEU involving the use of di-n-butylphthalate (CDH 1992; DOE 1995; DOE 1992). Therefore, the potential for di-n-butylphthalate to be present in RCEU surface soil as a result of historical site-related activities is unlikely.

4.8.2 Evaluation of Spatial Trends

Surface Soil (non-PMJM)

Di-n-butylphthalate was detected only twice (39 µg/kg and 44 4µg/kg), and in both instances the concentration exceeds the ESL of 16 µg/kg. As shown in Figure A3.4.10, the locations of the detections are not near an IHSS since there are no historical IHSSs in the RCEU. Thus, it appears that di-n-butylphthalate concentrations in RCEU surface soil do not show a pattern of release.

4.8.3 Pattern Recognition

Surface Soil (Non-PMJM)

Di-n-butylphthalate is not naturally occurring and, therefore, a pattern recognition analysis is not applicable.

4.8.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Di-n-butylphthalate is not naturally occurring and, therefore, a comparison to background analysis is not applicable.

4.8.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for di-n-butylphthalate (240 J µg/kg) exceeds the NOAEL ESL for two ecological receptors (insectivorous mourning dove and American kestrel).

4.8.6 Conclusion

The weight of evidence presented above shows that di-n-butylphthalate concentrations in RCEU surface soil (non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge. Di-n-butylphthalate is not considered an

ECOPC in surface soil for the RCEU and, therefore, is not further evaluated quantitatively.

4.9 Lithium

Lithium has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if lithium should be retained for risk characterization are summarized below.

4.9.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates a potential for lithium to have been released into RFETS soil because of the moderate lithium metal inventory and presence of lithium in waste generated during former operations. However, there are no IHSSs in the RCEU. Therefore, lithium is unlikely to be present in RCEU soil as a result of historical site-related activities.

4.9.2 Evaluation of Spatial Trends

Surface Soil (non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that lithium concentrations in RCEU surface soil reflect variations in naturally occurring lithium.

4.9.3 Pattern Recognition

Surface Soil (non-PMJM)

The probability plot for lithium concentrations suggests a single population, which indicates background conditions (Figure A3.4.11).

4.9.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Lithium concentrations in surface soil samples at the RCEU range from 6.80 to 17.7 mg/kg, with a mean concentration of 11.5 mg/kg and a standard deviation of 2.33 mg/kg. Lithium concentrations in the background data set range from 4.80 to 11.6 mg/kg, with a mean concentration of 7.66 mg/kg and a standard deviation of 1.89 mg/kg (Table A3.2.4). The concentrations of lithium in surface soil samples at the

RCEU are slightly elevated compared to background, but the data populations do overlap considerably.

Lithium concentrations reported in surface soil samples at the RCEU are well within the range for lithium in soils of Colorado and the bordering states (5 to 130 mg/kg, with mean concentration of 25.3 mg/kg and a standard deviation of 14.4 mg/kg) (Table A3.4.1).

4.9.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for lithium in the RCEU (16 mg/kg) exceeds the NOAEL ESL for only one receptor group, terrestrial plants (2 mg/kg). All other NOAEL ESLs were greater than the UTL and ranged from 610 to 18,431 mg/kg. The ESL for terrestrial plants is lower than all detected background concentrations. Because risks to ecological receptors are not expected at background concentrations, the terrestrial plant ESL may be overly conservative.

4.9.6 Conclusion

The weight of evidence presented above shows that lithium concentrations in RCEU surface soil (non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge; a spatial distribution indicative of naturally occurring lithium; a probability plot that suggests the presence of a single population which is also indicative of background conditions; and RCEU concentrations that are well within regional background levels. Lithium is not considered an ECOPC in surface soil for the RCEU and, therefore, is not further evaluated quantitatively.

4.10 Manganese

Manganese has concentrations statistically greater than background in surface soil/surface sediment and in surface soil in PMJM habitat in the RCEU. Manganese also has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL. Therefore, manganese in surface soil/surface sediment, surface soil (PMJM receptor), and surface soil (non-PMJM receptor) was carried forward to the professional judgment step. The lines of evidence used to determine if manganese should be retained for risk characterization are summarized below.

4.10.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates manganese is unlikely to be present in RFETS soil as a result of historical site-related activities.

4.10.2 Evaluation of Spatial Trends

Surface Soil/Surface Sediment

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that manganese concentrations in RCEU surface soil reflect variations in naturally occurring manganese.

Surface Soil (non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that manganese concentrations in RCEU surface soil reflect variations in naturally occurring manganese.

Surface Soil (PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that manganese concentrations in RCEU surface soil in PMJM habitat reflect variations in naturally occurring manganese.

4.10.3 Pattern Recognition

Surface Soil/Surface Sediment

The probability plot for manganese concentrations suggests a single population, which indicates background conditions (Figure A3.4.12).

Surface Soil (non-PMJM)

The probability plot of the natural logarithm of manganese concentrations indicates a single population extending from 160 to about 425 mg/kg, with two to three anomalous samples containing elevated manganese concentrations. The anomalous samples are too few to estimate the nature of this occurrence; however, because of the absence of sources in the RCEU, they could represent different background geologic conditions. (Figure A3.4.13).

4.10.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil/Surface Sediment

Manganese concentrations in surface soil/surface sediment samples at the RCEU range from 80.2 to 2,500 mg/kg, with a mean concentration of 385 mg/kg and a standard deviation of 446 mg/kg. Manganese concentrations in the background data set range from 9.00 to 1,280 mg/kg, with a mean concentration of 241 mg/kg and a standard deviation of 189 mg/kg (Table A3.2.2). The concentrations of manganese in surface soil samples at the RCEU are slightly elevated compared to background but the data populations do overlap considerably.

Manganese concentrations reported in surface soil samples at the RCEU are similar to the range for manganese in soils of Colorado and the bordering states (70 to 2,000 mg/kg, with a mean concentration of 414 mg/kg and a standard deviation of 272 mg/kg) (Table A3.4.1).

Surface Soil (Non-PMJM)

Manganese concentrations in surface soil samples at the RCEU range from 160 to 2,220 mg/kg, with a mean concentration of 363 mg/kg and a standard deviation of 333 mg/kg. Manganese concentrations in the background data set range from 129 to 357 mg/kg, with a mean concentration of 237 mg/kg and a standard deviation of 63.9 mg/kg (Table A3.2.4). The range of concentrations of manganese in the RCEU and background samples overlap considerably with only two of the 51 total detections greater than the background MDC.

Manganese concentrations reported in surface soil samples at the RCEU are similar to the range for manganese in soils of Colorado and the bordering states (70 to 2,000 mg/kg, with mean concentration of 414 mg/kg and a standard deviation of 272 mg/kg) (Table A3.4.1).

Surface Soil (PMJM)

Manganese concentrations in surface soil samples at the RCEU range from 160 to 2,220 mg/kg, with a mean concentration of 405 mg/kg and a standard deviation of 447 mg/kg. Manganese concentrations in the background data set range from 129 to 357 mg/kg, with a mean concentration of 237 mg/kg and a standard deviation of 63.9 mg/kg (Table A3.2.6). The range of concentrations of manganese in the RCEU and background samples overlap considerably with only two of the 51 total detections greater than the background MDC.

Manganese concentrations reported in surface soil samples at the RCEU are similar to the range for manganese in soils of Colorado and the bordering states (70 to 2,000 mg/kg, with mean concentration of 414 mg/kg and a standard deviation of 272 mg/kg) (Table A3.4.1).

4.10.5 Risk Potential for HHRA

Surface Soil/Surface Sediment

The manganese UCL for surface soil/surface sediment is 641 mg/kg. The UCL is less than two times greater than the PRG (419 mg/kg), with seven of the 51 detections greater than the PRG. The PRG is based on a hazard quotient (HQ) of D.1, therefore the risk to human health is well below the EPA guideline of an HQ of 1.

4.10.6 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for manganese in the RCEU (734 mg/kg) exceeds the NOAEL ESL for three receptor groups: terrestrial plants (500 mg/kg), deer mouse herbivore (486 mg/kg), and prairie dog (221 mg/kg). All other NOAEL ESLs were greater than the UTL and ranged from 1,032 to 19,115 mg/kg. None of the ESLs are within the range of background concentrations and are not likely to be overly conservative for use in screening level risk assessments.

Surface Soil (PMJM)

The MDC for manganese in the PMJM habitat within the RCEU (2,220 mg/kg) exceeds the NOAEL ESL for the PMJM (388 mg/kg). The PMJM ESL is not within the range of background concentrations and is not likely to be overly conservative for use in screening level risk assessments.

4.10.7 Conclusion

The weight of evidence presented above shows that manganese concentrations in RCEU surface soil/surface sediment as well as surface soil (both non-PMJM and PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge; spatial distributions indicative of naturally occurring manganese; probability plots that suggest the presence of single populations which are also indicative of background conditions; RCEU concentrations that are near regional background levels; and RCEU concentrations that are unlikely to result in significant risks to humans. Manganese is not considered a COC in surface soil/surface sediment or an ECOPC in surface soil for the RCEU and, therefore, is not further evaluated quantitatively.

4.11 Molybdenum

Molybdenum had an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if molybdenum should be retained for risk characterization are summarized below.

4.11.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates molybdenum is unlikely to be present in RFETS soil as a result of historical site-related activities.

4.11.2 Evaluation of Spatial Trends

Surface Soil (non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that molybdenum concentrations in RCEU surface soil reflect variations in naturally occurring molybdenum.

Surface Soil (PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that molybdenum concentrations in RCEU surface soil in PMJM habitat reflect variations in naturally occurring molybdenum.

4.11.3 Pattern Recognition

Surface Soil (non-PMJM)

Figure A3.4.14 is a probability plot of the detected molybdenum concentrations suggesting a single population, which indicates background conditions. This background population has a very limited range extending from 0.69 to 1.1 mg/kg, but with one anomalous sample containing an elevated molybdenum concentration of 2.7 mg/kg.

4.11.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

The reported range for molybdenum in surface soil within Colorado and the bordering states is 3 to 7 mg/kg, with a mean concentration of 1.59 mg/kg and a standard deviation of 0.522 mg/kg (Table A3.4.1). Molybdenum concentrations reported in surface soil samples at the RCEU is 0.690 to 2.70 mg/kg, with a mean concentration of 1.25 mg/kg and a standard deviation of 0.708 mg/kg (Table A3.2.4). The range of concentrations of

molybdenum in surface soil is below the range for molybdenum in soils of Colorado and the bordering states.

Surface Soil (PMJM)

The reported range for molybdenum in surface soil within Colorado and the bordering states is 3 to 7 mg/kg, with a mean concentration of 1.59 mg/kg and a standard deviation of 0.522 mg/kg (Table A3.4.1). Molybdenum concentrations reported in surface soil samples at the RCEU is 0.560 to 2.70 mg/kg, with a mean concentration of 1.26 mg/kg and a standard deviation of 0.734 mg/kg (Table A3.2.6). The range of concentrations of molybdenum in surface soil is below the range for molybdenum in soils of Colorado and the bordering states.

4.11.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for molybdenum in the RCEU (2.7 mg/kg) exceeds the NOAEL ESL for two receptor groups, terrestrial plants (2.0 mg/kg), and deer mouse insectivore (1.90 mg/kg). All other NOAEL ESLs were greater than the UTL and ranged from 6.97 to 275 mg/kg. Only the ESL for terrestrial plants is within the range of background concentrations. It is, therefore, likely to be overly conservative. None of the remaining ESLs are within the range of background concentrations and are not likely to be overly conservative for use in screening level risk assessments.

Surface Soil (PMJM)

The MDC for molybdenum within PMJM habitat in the RCEU (2.70 mg/kg) exceeds the NOAEL ESL for the PMJM (1.84 mg/kg). The PMJM ESL is not within the range of background concentrations and is not likely to be overly conservative for use in screening level risk assessments.

4.11.6 Conclusion

The weight of evidence presented above shows that molybdenum concentrations in RCEU surface soil (PMJM and non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge, a spatial distribution that suggests molybdenum is naturally occurring, a probability plot that suggests the presence of a single population which is also indicative of background conditions, and RCEU concentrations that are well within regional background levels. Molybdenum is not considered an ECOPC in surface soil for the RCEU and, therefore, is not further evaluated quantitatively.

4.12 Nickel

Nickel had an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. In addition, nickel in surface soil (for PMJM receptors) had concentrations statistically greater than background, and was carried forward to the professional judgment step. The lines of evidence used to determine if nickel should be retained for risk characterization are summarized below.

4.12.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates a potential for nickel to have been released into RFETS soil because of the moderate nickel metal inventory and presence of nickel in waste generated during former operations. However, there are no IHSSs in the RCEU. Therefore, nickel is unlikely to be present in RCEU soil as a result of historical site-related activities.

4.12.2 Evaluation of Spatial Trends

Surface Soil (non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that nickel concentrations in RCEU surface soil reflect variations in naturally occurring nickel.

Surface Soil (PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that nickel concentrations in RCEU surface soil in PMJM habitat reflect variations in naturally occurring nickel.

4.12.3 Pattern Recognition

Surface Soil (non-PMJM)

The probability plot for nickel concentrations suggests a single population which indicates background conditions (Figure A3.4.15).

4.12.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Nickel concentrations in surface soil samples at the RCEU range from 7.8 to 25.0 mg/kg, with a mean concentration of 12.5 mg/kg and a standard deviation of 3.57 mg/kg. Nickel concentrations in the background data set range from 3.8 to 14.0 mg/kg, with a mean

concentration of 9.6 mg/kg and a standard deviation of 2.59 mg/kg (Table A3.2.4). The range of concentrations of nickel in the RCEU and background samples overlap and the means are similar.

The reported range for nickel in surface soil within Colorado and the bordering states is 5 to 700 mg/kg, with a mean concentration of 18.8 mg/kg and a standard deviation of 39.8 mg/kg (Table A3.4.1). Nickel concentrations reported in surface soil samples at the RCEU is 7.80 to 25.0 mg/kg, with a mean concentration of 12.5 mg/kg and a standard deviation of 3.57 mg/kg (Table A3.2.4). The range of concentrations of nickel in surface soil is at the low end of the range for nickel in soils of Colorado and the bordering states.

Surface Soil (PMJM)

The reported range for nickel in surface soil within Colorado and the bordering states is 5 to 700 mg/kg, with a mean concentration of 18.8 mg/kg and a standard deviation of 39.8 mg/kg (Table A3.4.1). Nickel concentrations reported in surface soil samples at the RCEU is 8.20 to 25.0 mg/kg, with a mean concentration of 12.8 mg/kg and a standard deviation of 4.15 mg/kg (Table A3.2.6). The range of concentrations of nickel in surface soil is at the low end of the range for nickel in soils of Colorado and the bordering states.

4.12.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for nickel in the RCEU (18.7 mg/kg) exceeds the NOAEL ESL for six receptor groups: mourning dove insectivore (1.24 mg/kg), American kestrel (13.1 mg/kg), deer mouse herbivore (16.4 mg/kg), deer mouse insectivore (0.43 mg/kg), coyote generalist (6.02 mg/kg), and coyote insectivore (1.86 mg/kg). All other NOAEL ESLs were greater than the UTL and ranged from 30 to 200 mg/kg. All of the ESLs exceeded by the UTL (except deer mouse herbivore) are lower than the MDC in background surface soils. Because risks are not typically expected at background concentrations, these ESLs may be overly conservative.

Surface Soil (PMJM)

The MDC for nickel in PMJM habitat in the RCEU (25.0 mg/kg) exceeds the NOAEL ESL for PMJM (0.51 mg/kg). All 18 samples in PMJM habitat had concentrations greater than the NOAEL ESL of 0.5 mg/kg for the PMJM. The ESL is less than all background samples. Because risk is not typically expected at background concentrations, it is likely that the PMJM ESL may be overly conservative.

4.12.6 Conclusion

The weight of evidence presented above shows that nickel concentrations in RCEU surface soil (PMJM and non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge; a spatial distribution that suggests nickel is naturally occurring; a probability plot that suggests the presence of a single population which is also indicative of background conditions; and RCEU concentrations that are well within regional background levels. Nickel is not considered an ECOPC in surface soil for the RCEU and, therefore, is not further evaluated quantitatively.

4.13 Radium-228

Radium-228 has activities statistically greater than background in surface soil/surface sediment, and was carried forward to the professional judgment step. The lines of evidence used to determine if radium-228 should be retained for risk characterization are summarized below.

4.13.1 Summary of Process Knowledge

The ChemRisk Task 1 Report did not identify radium-228 as a radionuclide used at RFETS (CDPH 1991a) and no radium-228 waste was reported to have been generated. It is unlikely that radium-228 is present in soil at RFETS as a result of historical site-related activities.

4.13.2 Evaluation of Spatial Trends

Surface Soil/Surface Sediment

As shown in Figure A3.4.16, radium-228 concentrations exceed the PRG of 0.111 pCi/g at locations throughout the RCEU. There are no locations where the radium-228 concentration exceeds the background MDC, and none of the locations are near IHSSs since no historical IHSSs are designated in the RCEU. Thus, it appears that radium-228 activities in RCEU surface soil reflect variations in naturally occurring radium-228.

4.13.3 Pattern Recognition

Surface Soil/Surface Sediment

The probability plot for radium-228 activities suggests a single population, which is indicative of background conditions (Figure A3.4.17).

4.13.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil/Surface Sediment

Radium-228 activities in surface soil/surface sediment samples at the RCEU range from 1.30 to 2.90 picocuries per gram (pCi/g) with a mean activity of 2.01 pCi/g and a standard deviation of 0.572 pCi/g. The radium-228 activities in the background data set range from 0.200 to 4.10 pCi/g with a mean activities of 1.60 pCi/g and a standard deviation of 0.799 pCi/g (Table A3.2.2). The range of radium-228 activities in the RCEU and background samples considerably overlap and the means are similar. Furthermore, radium-228 activities in RCEU surface soil/surface sediment are all below the background MDC.

4.13.5 Risk Potential for HHRA

The radium-228 UCL for surface soil/surface sediment is 2.20 pCi/g. The PRG is 0.111 pCi/g, with all of the detections greater than the PRG. Because the PRG is based on an excess carcinogenic risk of 1E-06, the cancer risk based on the UCL activity is less than 2E-05, and is well within the NCP risk range of 1E-06 to 1E-04. Because the radium-228 activities appear to be naturally occurring, the excess cancer risks to the WRW from exposure to radium-228 in surface soil/surface sediment in the RCEU is similar to background risk.

4.13.6 Conclusion

The weight of evidence presented above shows that radium-228 activities in RCEU surface soil/surface sediment are not likely to be a result of historical site-related activities based on process knowledge; a spatial distribution indicative of naturally occurring radium-228; a probability plot that suggests the presence of a single population which is also indicative of background conditions; and RCEU activity that are unlikely to result in risks to humans significantly above background risks. Radium-228 is not considered a COC in surface soil/surface sediment or an ECOPC in surface soil for the RCEU and, therefore, is not further evaluated quantitatively.

4.14 Tin

Tin has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if tin should be retained for risk characterization are summarized below.

4.14.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates a potential for tin to have been released into RFETS soil because of the moderate tin metal inventory during former operations. However, there are no IHSSs in the RCEU. Therefore tin is unlikely to be present in RCEU soil as a result of historical site-related activities.

4.14.2 Evaluation of Spatial Trends

Surface Soil (non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that tin concentrations in RCEU surface soil reflect variations in naturally occurring tin.

Surface Soil (PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that tin concentrations in RCEU surface soil in PMJM habitat reflect variations in naturally occurring tin.

4.14.3 Pattern Recognition

Surface Soil (non-PMJM)

The probability plot for detected concentrations of tin suggests two populations separated by a large discontinuity (Figure A3.4.18). Two populations separated by a discontinuity are possible but unusual in a natural setting. Review of the data indicates that these two populations represent two sampling events and, therefore, sampling and/or analytical methods may be the underlying cause.

4.14.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

The reported range for tin in surface soil within Colorado and the bordering states is 0.117 to 5.001 mg/kg, with a mean concentration of 1.15 mg/kg and a standard deviation of 0.772 mg/kg (Table A3.4.1). Tin concentrations reported in surface soil samples at the RCEU are 1.20 to 41.9 mg/kg, with a mean concentration of 13.7 mg/kg and a standard deviation of 14.0 mg/kg (Table A3.2.4). The range of concentrations of tin in surface soil is greater than the range for tin in soils of Colorado and the bordering states.

Surface Soil (PMJM)

The reported range for tin in surface soil within Colorado and the bordering states is 0.117 to 5.001 mg/kg, with a mean concentration of 1.15 mg/kg and a standard deviation of 0.772 mg/kg (Table A3.4.1). Tin concentrations reported in surface soil samples at the RCEU are 1.20 to 33.0 mg/kg, with a mean concentration of 10.1 mg/kg and a standard deviation of 12.3 mg/kg (Table A3.2.6). The range of concentrations of tin in surface soil is greater than the range for tin in soils of Colorado and the bordering states.

4.14.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for tin in the RCEU (41.3 mg/kg) exceeds the NOAEL ESL for six receptor groups: mourning dove herbivore (26.1 mg/kg), mourning dove insectivore (2.90 mg/kg), American kestrel (18.98 mg/kg), deer mouse insectivore (3.77 mg/kg), coyote generalist (36.1 mg/kg), and coyote insectivore (16.2 mg/kg). All other NOAEL ESLs were greater than the UTL and ranged from 45.0 to 242 mg/kg. None of the ESLs, except the mourning dove insectivore and deer mouse insectivore, are within the range of background concentrations and are not likely to be overly conservative for use in screening level risk assessments.

Surface Soil (PMJM)

The MDC for tin in PMJM habitat in the RCEU (33.0 mg/kg) exceeds the NOAEL ESL for the PMJM (4.22). All other NOAEL ESLs were greater than the MDC and ranged from 36.1 to 242 mg/kg. The ESL is within the range of background concentrations and is likely to be overly conservative for use in screening level risk assessments.

4.14.6 Conclusion

The weight of evidence presented above shows that tin concentrations in RCEU surface soil (PMJM and non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge and a spatial distribution indicative of naturally occurring tin. The two populations of tin concentrations in the RCEU appear to be related to sampling and/or analytical methods. Tin is not considered an ECOPC in surface soil for the RCEU and, therefore, is not further evaluated quantitatively.

4.15 Vanadium

Vanadium has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. In addition,

vanadium in surface soil (for PMJM receptors) has concentrations statistically greater than background, and was carried forward to the professional judgment step. The lines of evidence used to determine if vanadium should be retained as a COC are summarized below.

4.15.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates vanadium is unlikely to be present in RFETS soil as a result of historical site-related activities.

4.15.2 Evaluation of Spatial Trends

Surface Soil (non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that vanadium concentrations in RCEU surface soil reflect variations in naturally occurring vanadium.

Surface Soil (PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that vanadium concentrations in RCEU surface soil in PMJM habitat reflect variations in naturally occurring vanadium.

4.15.3 Pattern Recognition

Surface Soil (non-PMJM)

The probability plot for vanadium concentrations suggests a single population which indicates background conditions (Figure A3.4.19)

4.15.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Vanadium concentrations in surface soil samples at the RCEU range from 21.1 to 49.0 mg/kg, with a mean concentration of 33.1 mg/kg and a standard deviation of 6.84 mg/kg. Vanadium concentrations in the background data set range from 10.8 to 45.8 mg/kg, with a mean concentration of 27.7 mg/kg and a standard deviation of 7.68 mg/kg (Table A3.2.4). The range of concentrations of vanadium in the RCEU and background samples considerably overlap and the means are similar.

The reported range for vanadium in surface soil within Colorado and the bordering states is 7 to 300 mg/kg, with a mean concentration of 73 mg/kg and a standard deviation of

41.7 mg/kg (Table A3.4.1). Vanadium concentrations reported in surface soil samples at the RCEU are 21.1 to 49.0 mg/kg, with a mean concentration of 33.1 mg/kg and a standard deviation of 6.84 mg/kg (Table A3.2.4). The range of concentrations of vanadium in surface soil is within the range for vanadium in soils of Colorado and the bordering states.

Surface Soil (PMJM)

Vanadium concentrations in PMJM habitat surface soil at the RCEU range from 21.1 to 49.0 mg/kg, with a mean concentration of 33.5 mg/kg and a standard deviation of 7.83 mg/kg. Vanadium concentrations in the background data set range from 10.8 to 45.8 mg/kg, with a mean concentration of 27.7 mg/kg and a standard deviation of 7.68 mg/kg (Table A3.2.6). The range of concentrations of vanadium in the RCEU and background samples considerably overlap and the means are similar.

The reported range for vanadium in surface soil within Colorado and the bordering states is 7 to 300 mg/kg, with a mean concentration of 73 mg/kg and a standard deviation of 41.7 mg/kg (Table A3.4.1). Vanadium concentrations reported in surface soil samples at the RCEU are 21.1 to 49.0 mg/kg, with a mean concentration of 33.1 mg/kg and a standard deviation of 6.84 mg/kg (Table A3.2.4). The range of concentrations of vanadium in surface soil is within the range for vanadium in soils of Colorado and the bordering states.

4.15.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for vanadium in the RCEU (44.9 mg/kg) exceeds the NOAEL ESL for two receptor groups: terrestrial plants (2 mg/kg), and deer mouse insectivore (29.9 mg/kg). All other NOAEL ESLs were greater than the UTL and ranged from 63.7 to 1,514 mg/kg. Both of the ESLs are below or within the range of background concentrations. Because risks are not typically expected at background concentrations, these ESLs are likely to be overly conservative.

Surface Soil (PMJM)

The MDC for vanadium in PMJM habitat in the RCEU (49.0 mg/kg) exceeds the NOAEL ESL for the PMJM (21.6 mg/kg). This ESL is less than all but three background surface soil concentrations. Because risks are not typically expected at background concentrations, this ESL is likely to be overly conservative.

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4.15.6 Conclusion

The weight of evidence presented above shows that vanadium concentrations in RCEU surface soil (PMJM and non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge; a spatial distribution that suggests vanadium is naturally occurring; a probability plot that suggests the presence of a single population which is also indicative of background conditions; and RCEU concentrations that are well within regional background levels. Vanadium is not considered an ECOPC in surface soil for the RCEU and, therefore, is not further evaluated quantitatively.

4.16 Zinc

Zinc has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. In addition, zinc in surface soil (non-PMJM) has concentrations statistically greater than background. The lines of evidence used to determine if zinc should be retained for risk characterization are summarized below.

4.16.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates a potential for zinc to have been released into RFETS soil because of the moderate zinc metal inventory and the presence of zinc in waste generated during former operations. However, there are no IHSSs in the RCEU. Therefore, zinc is unlikely to be present in RCEU soil as a result of historical site-related activities.

4.16.2 Evaluation of Spatial Trends

Surface Soil (non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that zinc concentrations in RCEU surface soil reflect variations in naturally occurring zinc.

4.16.3 Pattern Recognition

Surface Soil (non-PMJM)

The probability plot for zinc concentrations suggests one population extending from 36 to about 65 mg/kg, with four anomalous samples containing elevated zinc concentrations. The anomalous samples are too few to estimate the nature of this occurrence; however, because of the absence of sources in the RCEU, they could represent different background geologic conditions.

4.16.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Zinc concentrations in surface soil samples at the RCEU range from 36.0 to 130.0 mg/kg, with a mean concentration of 56.4 mg/kg and a standard deviation of 16.7 mg/kg. Zinc concentrations in the background data set range from 21.1 to 75.9 mg/kg, with a mean concentration of 49.8 mg/kg and a standard deviation of 12.2 mg/kg (Table A3.2.4). The range of concentrations of zinc in the RCEU and background samples considerably overlap and the means are similar.

The reported range for zinc in surface soil within Colorado and the bordering states is 10 to 2,080 mg/kg, with a mean concentration of 72.4 mg/kg and a standard deviation of 159 mg/kg (Table A3.4.1). Zinc concentrations reported in surface soil samples at the RCEU are 36.0 to 130 mg/kg, with a mean concentration of 56.4 mg/kg and a standard deviation of 16.7 mg/kg (Table A3.2.4). The range of concentrations of zinc in surface soil is within the range for zinc in soils of Colorado and the bordering states.

4.16.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for zinc in the RCEU (90.2 mg/kg) exceeds the NOAEL ESL for three receptor groups: terrestrial plants (50 mg/kg), mourning dove insectivore (0.65 mg/kg), and deer mouse insectivore (5.29 mg/kg). All other NOAEL ESLs were greater than the UTL and ranged from 109 to 16,489 mg/kg. The mourning dove and deer mouse (insectivore) ESLs are both considerably lower than all zinc concentrations in background soils. Because risks are not typically expected at background concentrations, it is likely that these ESLs are overly conservative. The terrestrial plant ESL is approximately equal to the mean background concentration, again indicating that it may be overly conservative for use in the risk assessment.

4.16.6 Conclusion

The weight of evidence presented above shows that zinc concentrations in RCEU surface soil (non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge; a spatial distribution indicative of naturally occurring zinc; and RCEU concentrations that are well within regional background levels. Although there may be two data populations present for RCEU surface soil, the absence of historical sources suggest this represents two background geologic conditions. Zinc is not considered an ECOPC in surface soil for the RCEU and, therefore, is not further evaluated quantitatively.

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TABLES

Table A3.2.1
Statistical Distribution and Comparison to Background for RCEU Surface Soil/Surface Sediment

Analyte	Units	Statistical Distribution Testing Results						Background Comparison Test		
		Background Data Set			RCEU Data Set (excluding background samples)					
		Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Statistically Greater than Background?
Arsenic	mg/kg	73	GAMMA	91.8	46	NONPARAMETRIC	100.00	WRS	2.29E-07	Yes
Manganese	mg/kg	73	GAMMA	100.0	46	NONPARAMETRIC	100.00	WRS	6.23E-04	Yes
Cesium-134	pCi/g	77	NONPARAMETRIC	100.0	11	NORMAL	100.00	WRS	0.999	No
Cesium-137	pCi/g	105	NONPARAMETRIC	100.0	18	NORMAL	100.00	WRS	0.024	Yes
Radium-228	pCi/g	40	GAMMA	100.0	14	NORMAL	100.00	WRS	0.012	Yes

Test: WRS = Wilcoxon Rank Sum.
t-Test_N = Student's t-test using normal data.
N/A = Not applicable. Background comparison was not performed because background data were not available or detection frequency of an analyte in EU or background data set is less than 20 percent.

Table A3.2.2

Summary Statistics for Background and RCEU Surface Soil/Surface Sediment[a]

Analyte	Units	Background Data Set					RCEU Data Set (excluding background samples)				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation
Arsenic	mg/kg	73	0.270	9.60	3.42	2.55	46	1.70	15.0	5.89	2.29
Manganese	mg/kg	73	9.00	1,280	241	189	46	80.2	2,500	385	446
Cesium-134	pCi/g	77	1.00E-03	0.300	0.141	0.066	11	0.059	0.100	0.082	0.014
Cesium-137	pCi/g	105	-0.027	1.80	0.692	0.492	18	0.103	2.50	1.01	0.710

[a] Statistics are computed using one-half of the reported values for nondetects.

Table A3.2.3
Statistical Distribution and Comparison to Background for RCEU Surface Soil (non-PMJM)

Analyte	Units	Statistical Distribution Testing Results						Background Comparison Test Results		
		Background Data Set			RCEU Data Set (excluding background samples)			Test	1 - p	Statistically Greater than Background?
		Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)			
Aluminum	mg/kg	20	NORMAL	100	36	NORMAL	100	WRS	1.08E-05	**Yes**
Arsenic	mg/kg	20	NORMAL	100	36	NORMAL	100	WRS	0.504	No
Barium	mg/kg	20	NORMAL	100	36	NONPARAMETRIC	100	WRS	1.33E-08	**Yes**
Boron	mg/kg	N/A	N/A	N/A	17	NORMAL	100	N/A	N/A	**Yes[a]**
Cadmium	mg/kg	20	NONPARAMETRIC	65	34	GAMMA	47.1	WRS	0.994	No
Chromium	mg/kg	20	NORMAL	100	36	NORMAL	100	WRS	1.04E-06	**Yes**
Cobalt	mg/kg	20	NORMAL	100	36	NONPARAMETRIC	100	WRS	0.854	No
Copper	mg/kg	20	NONPARAMETRIC	100	36	NORMAL	100	WRS	0.369	No
Lead	mg/kg	20	NORMAL	100	36	NORMAL	100	WRS	0.560	No
Lithium	mg/kg	20	NORMAL	100	36	NORMAL	100	WRS	2.27E-08	**Yes**
Manganese	mg/kg	20	NORMAL	100	36	NONPARAMETRIC	100	WRS	0.001	**Yes**
Mercury	mg/kg	20	NONPARAMETRIC	40	34	NONPARAMETRIC	50	WRS	1.000	No
Molybdenum	mg/kg	20	NORMAL	0	36	NONPARAMETRIC	50	N/A	N/A	**Yes[a]**
Nickel	mg/kg	20	NORMAL	100	36	GAMMA	97.2	WRS	0.002	**Yes**
Selenium	mg/kg	20	NONPARAMETRIC	60	36	NONPARAMETRIC	44.4	WRS	0.930	No
Tin	mg/kg	20	NORMAL	0	36	NONPARAMETRIC	33.3	N/A	N/A	**Yes[a]**
Vanadium	mg/kg	20	NORMAL	100	36	NORMAL	100	WRS	0.005	**Yes**
Zinc	mg/kg	20	NORMAL	100	36	NONPARAMETRIC	100	WRS	0.097	**Yes**

WRS = Wilcoxon Rank Sum.
t-Test_N = Student's t-test using normal data.
N/A = Not applicable.
Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table A3.2.4

Summary Statistics for Background and RCEU Surface Soil (non-PMJM)[a]

Analyte	Units	Background Data Set					RCEU Data Set (excluding background samples)				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation
Aluminum	mg/kg	20	4,050	17,100	10,203	3,256	36	7,420	21,800	14,530	3,375
Arsenic	mg/kg	20	2.30	9.60	6.09	2.00	36	2.20	8.70	6.08	1.50
Barium	mg/kg	20	45.7	134	102	19.4	36	110	470	168	73.9
Boron	mg/kg	N/A	N/A	N/A	N/A	N/A	17	3.90	7.90	5.72	1.00
Cadmium	mg/kg	20	0.670	2.30	0.708	0.455	34	0.075	1.80	0.456	0.427
Chromium	mg/kg	20	5.50	16.9	11.2	2.78	36	9.00	22.0	15.4	2.78
Cobalt	mg/kg	20	3.40	11.2	7.27	1.79	36	4.80	24.0	7.33	3.22
Cobalt	mg/kg	20	5.20	16.0	13.0	2.58	36	7.70	22.2	13.5	3.43
Copper	mg/kg	20	8.60	53.3	33.5	10.5	36	21.0	51.0	33.2	7.72
Lead	mg/kg	20	4.80	11.6	7.66	1.89	36	6.80	17.7	11.5	2.33
Manganese	mg/kg	20	129	357	237	63.9	36	160	2,220	363	333
Lithium	mg/kg	20	0.090	0.120	0.072	0.031	34	0.021	0.051	0.038	0.014
Manganese	mg/kg	20	N/A	N/A	0.573	0.184	36	0.690	2.70	1.25	0.708
Mercury	mg/kg	20	3.80	14.0	9.60	2.59	36	7.80	25.0	12.5	3.57
Molybdenum	mg/kg	20	0.680	1.40	0.628	0.305	36	0.280	1.30	0.490	0.245
Nickel	mg/kg	20	10.8	45.8	27.7	7.68	36	21.1	49.0	33.1	6.84
Selenium	mg/kg	20	21.1	75.9	49.8	12.2	36	36.0	130	56.4	16.7
Cesium-134	pCi/g	70	0.050	0.300	0.148	0.059	8	0.071	0.100	0.085	0.012
Cesium-137	pCi/g	70	0.070	1.80	0.911	0.391	11	0.710	2.50	1.43	0.509

[a] Statistics are computed using one-half of the reported values for nondetects.

Table A3.2.5
Statistical Distributions and Comparison to Background for for RCEU Surface Soil (PMJM)

Analyte	Units	Statistical Distribution Testing Results						Background Comparison Test Results		
		Background Data Set			RCEU Data Set (excluding background samples)					
		Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Statistically Greater than Background
Arsenic	mg/kg	20	NORMAL	100.0	19	NORMAL	100.00	t-Test_N	0.260	No
Chromium	**mg/kg**	**20**	**NORMAL**	**100.0**	**19**	**NORMAL**	**100.00**	**t-Test_N**	**5.58E-05**	**Yes**
Manganese	mg/kg	20	NORMAL	100.0	19	NONPARAMETRIC	100.00	WRS	0.005	Yes
Molybdenum	mg/kg	20	NORMAL	0.0	19	NONPARAMETRIC	63.16	N/A	N/A	N/A
Nickel	**mg/kg**	**20**	**NORMAL**	**100.0**	**19**	**GAMMA**	**94.74**	**WRS**	**0.008**	**Yes**
Selenium	**mg/kg**	**20**	**NONPARAMETRIC**	**60.0**	**19**	**NONPARAMETRIC**	**31.58**	**WRS**	**0.916**	**No**
Tin	**mg/kg**	**20**	**NORMAL**	**0.0**	**19**	**NONPARAMETRIC**	**36.84**	**N/A**	**N/A**	**N/A**
Vanadium	**mg/kg**	**20**	**NORMAL**	**100.0**	**19**	**NORMAL**	**100.00**	**t-Test_N**	**0.014**	**Yes**
Zinc	mg/kg	20	NORMAL	100.0	19	NONPARAMETRIC	100.00	WRS	0.188	No

WRS = Wilcoxon Rank Sum.

t-Test_N = Student's t-test using normal data.

Bold = Analyte retained for further consideration in the next ECOPC selection step.

N/A =

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Table A3.2.6
Summary Statistics for Background and RCEU Surface Soil (PMJM)[a]

Analyte	Units	Background Data					RCEU Data Set (excluding background samples)				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation
Arsenic	mg/kg	20	2.30	9.60	6.09	2.00	19	4.80	8.70	6.43	1.23
Chromium	mg/kg	20	5.50	16.9	11.2	2.78	19	9.00	21.6	15.2	2.93
Manganese	mg/kg	20	129	357	237	63.9	19	160	2,220	405	447
Molybdenum	mg/kg	20	N/A	N/A	0.573	0.184	19	0.560	2.70	1.26	0.734
Nickel	mg/kg	20	3.80	14.0	9.60	2.59	19	8.20	25.0	12.8	4.15
Selenium	mg/kg	20	0.680	1.40	0.628	0.305	19	0.370	1.30	0.465	0.244
Tin	mg/kg	20	N/A	N/A	2.06	0.410	19	1.20	33.0	10.1	12.3
Vanadium	mg/kg	20	10.8	45.8	27.7	7.68	19	21.1	49.0	33.5	7.83
Zinc	mg/kg	20	21.1	75.9	49.8	12.2	19	36.0	130	57.1	21.2

a Statistics are computed using one-half of the reported values for nondetects.

Table A3.2.7
Statistical Distributions and Comparison to Background for RCEU Subsurface Soil

Analyte	Units	Statistical Distribution Testing Results						Background Comparison Test Results		
		Background Data Set			RCEU Data Set (excluding background samples)					
		Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Statistically Greater than Background
Arsenic	mg/kg	45	NONPARAMETRIC	93.3	8	NORMAL	100.00	WRS	0.015	Yes

Test: WRS = Wilcoxon Rank Sum.
Bold = Analyte retained for further consideration in the next ECOPC selection step.

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Table A3.2.8

Summary Statistics for Background and RCEU Subsurface Soil[a]

Analyte	Units	Background Data Set					RCEU Data Set (excluding background samples)				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation
Arsenic	mg/kg	45	1.70	41.8	5.48	6.02	8	2.50	13.1	8.08	4.07

a Statistics are computed using one-half of the reported values for nondetects.

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table A3.4.1

Summary of Element Concentrations in Colorado and Bordering States Surface Soil[a]

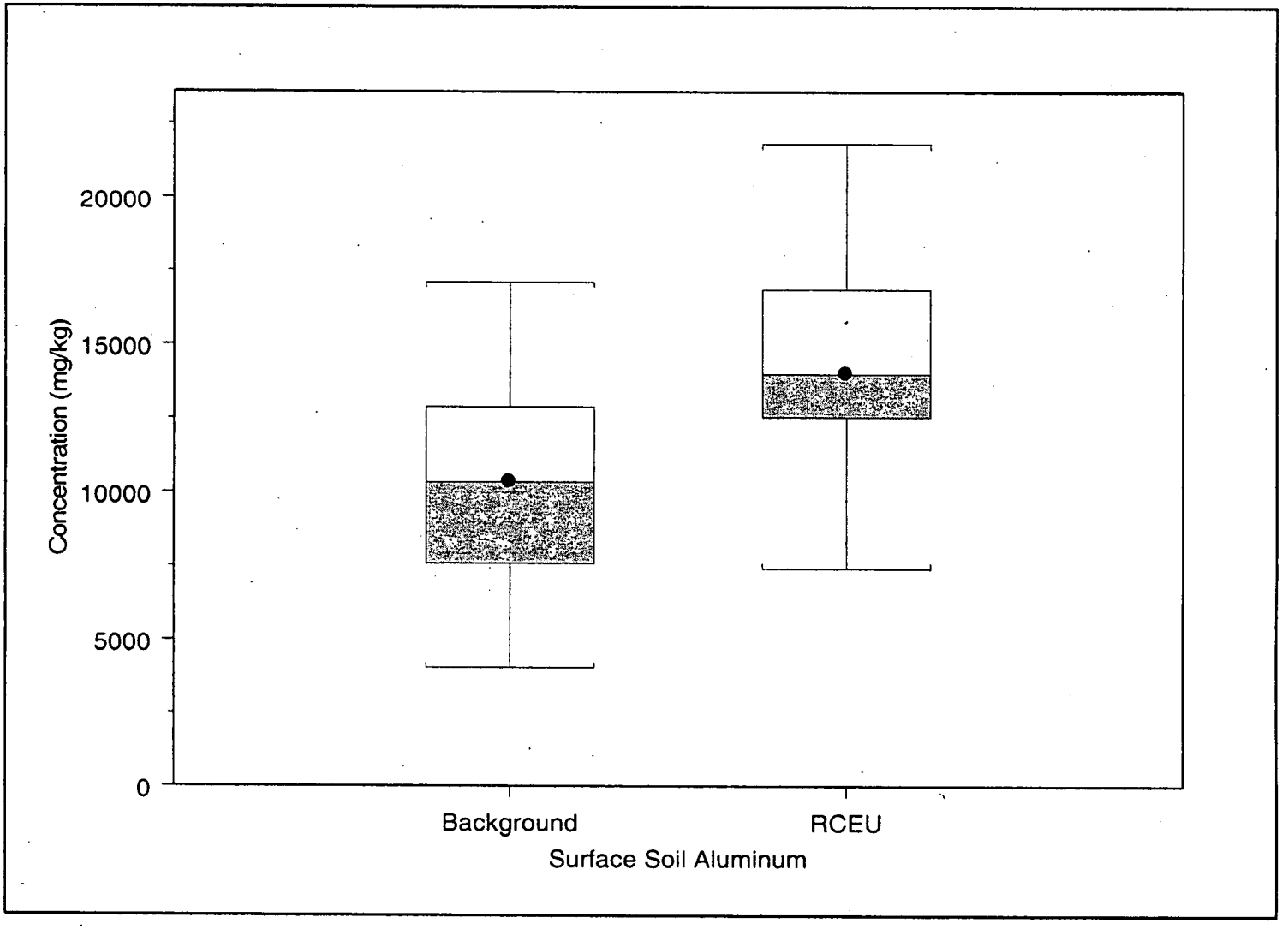
Analyte	Total Number of Results	Detection Frequency (%)	Range of Detected Values (mg/kg)	Average[b] (mg/kg)	Standard Deviation[b] (mg/kg)
Aluminum	303	100	5,000 - 100,000	50,800	23,500
Antimony	84	15.0	1.038 - 2.531	0.647	0.378
Arsenic	307	99.0	1.224 - 97	6.9	7.64
Barium	342	100	100 - 3,000	642	330
Beryllium	342	36.0	1 - 7	0.991	0.876
Boron	342	67.0	20 - 150	27.9	19.7
Bromine	85	51.0	0.5038 - 3.522	0.681	0.599
Calcium	342	100	0.055 - 32	3.09	4.13
Carbon	85	100	0.3 - 10	2.18	1.92
Cerium	291	16.0	150 - 300	90	38.4
Chromium	342	100	3 - 500	48.2	41
Cobalt	342	88.6	3 - 30	8.09	5.03
Copper	342	100	2 - 200	23.1	17.7
Fluorine	264	97.3	10 - 1,900	394	261
Gallium	340	99.1	5 - 50	18.3	8.9
Germanium	85	100	0.5777 - 2.146	1.18	0.316
Iodine	85	78.8	0.516 - 3.487	1.07	0.708
Iron	342	100	3,000 - 100,000	21,100	13,500
Lanthanum	341	66.3	30 - 200	39.8	28.8
Lead	342	92.7	10 - 700	24.8	41.5
Lithium	307	100	5 - 130	25.3	14.4
Magnesium	341	100	300 - 50,000	8,630	6,400
Manganese	342	100	70 - 2,000	414	272
Mercury	309	99.0	0.01 - 4.6	0.0768	0.276
Molybdenum	340	3.50	3 - 7	1.59	0.522
Neodymium	256	22.7	70 - 300	47.1	31.7
Nickel	342	96.5	5 - 700	18.8	39.8
Niobium	335	63.3	10 - 100	11.4	8.68
Phosphorus	249	100	40 - 4,497	399	397
Potassium	341	100	1,900 - 63,000	18,900	6,980
Rubidium	85	100	35 - 140	75.8	25
Scandium	342	85.1	5 - 30	8.64	4.69
Selenium	309	80.6	0.1023 - 4.3183	0.349	0.415
Silicon	85	100	149,340 - 413,260	302,000	61,500
Sodium	335	100	500 - 70,000	10,400	6,260
Strontium	342	100	10 - 2,000	243	212
Sulfur	85	16.5	816 - 47,760	1,250	5,300
Thallium	76	100	2.45 - 20.79	9.71	3.54
Tin	85	96.5	0.117 - 5.001	1.15	0.772
Titanium	342	100	500 - 7,000	2,290	1,350
Uranium	85	100	1.11 - 5.98	2.87	0.883
Vanadium	342	100	7 - 300	73	41.7
Ytterbium	330	99.1	1 - 20	3.33	2.06
Yttrium	342	98.0	10 - 150	26.9	18.1
Zinc	330	100	10 - 2,080	72.4	159
Zirconium	342	100	30 - 1,500	220	157

[a] Based on data from Shacklette and Boerngen 1984 for the states of Colorado, Arizona, Kansas, Nebraska, New Mexico, Oklahoma, Utah, and Wyoming.

[b] One-half the detection limit used as proxy value for nondetects in computation of the mean and standard deviation.

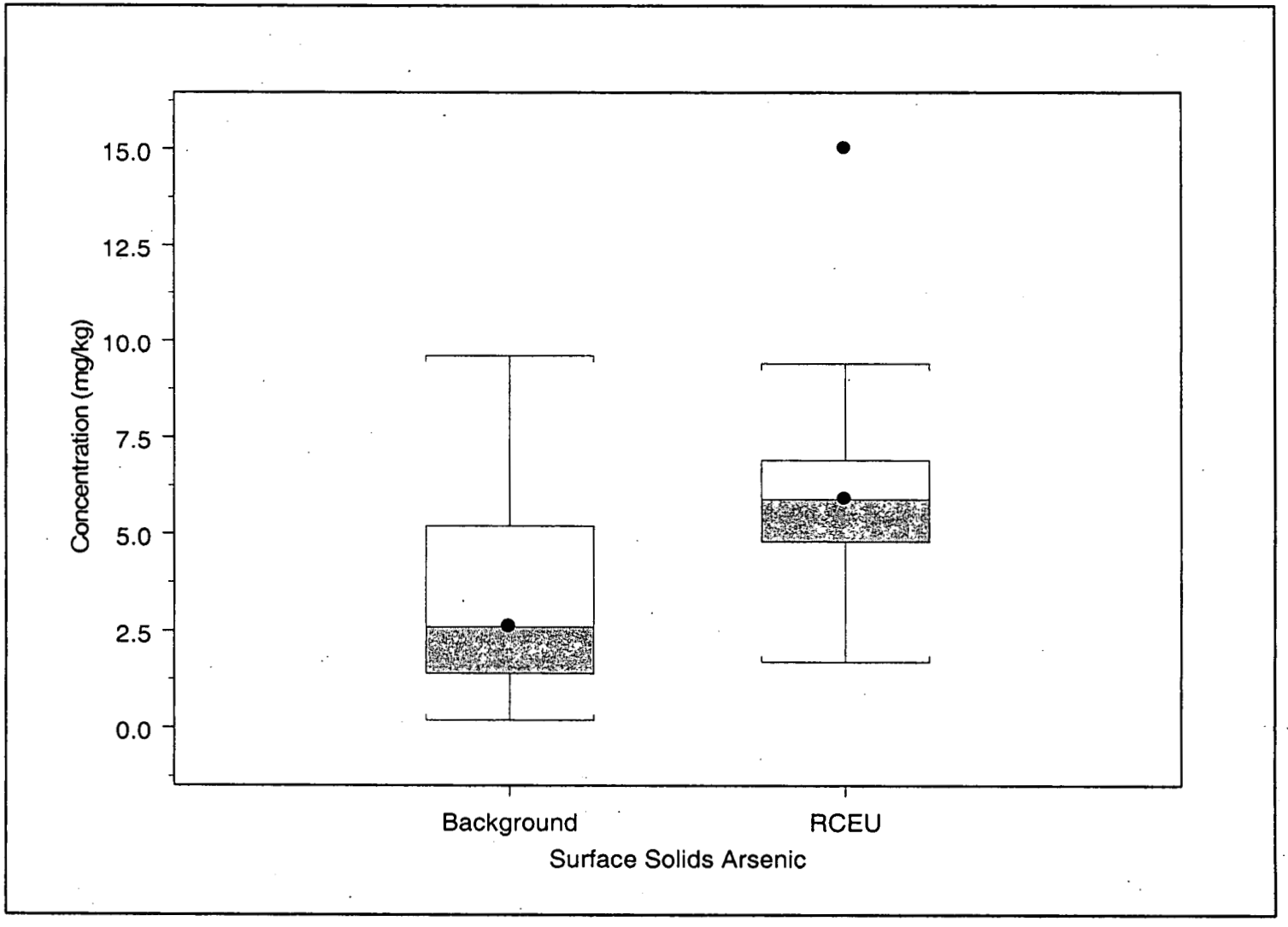
FIGURES

Figure 2.1
RCEU Surface Soil Box Plots for Aluminum



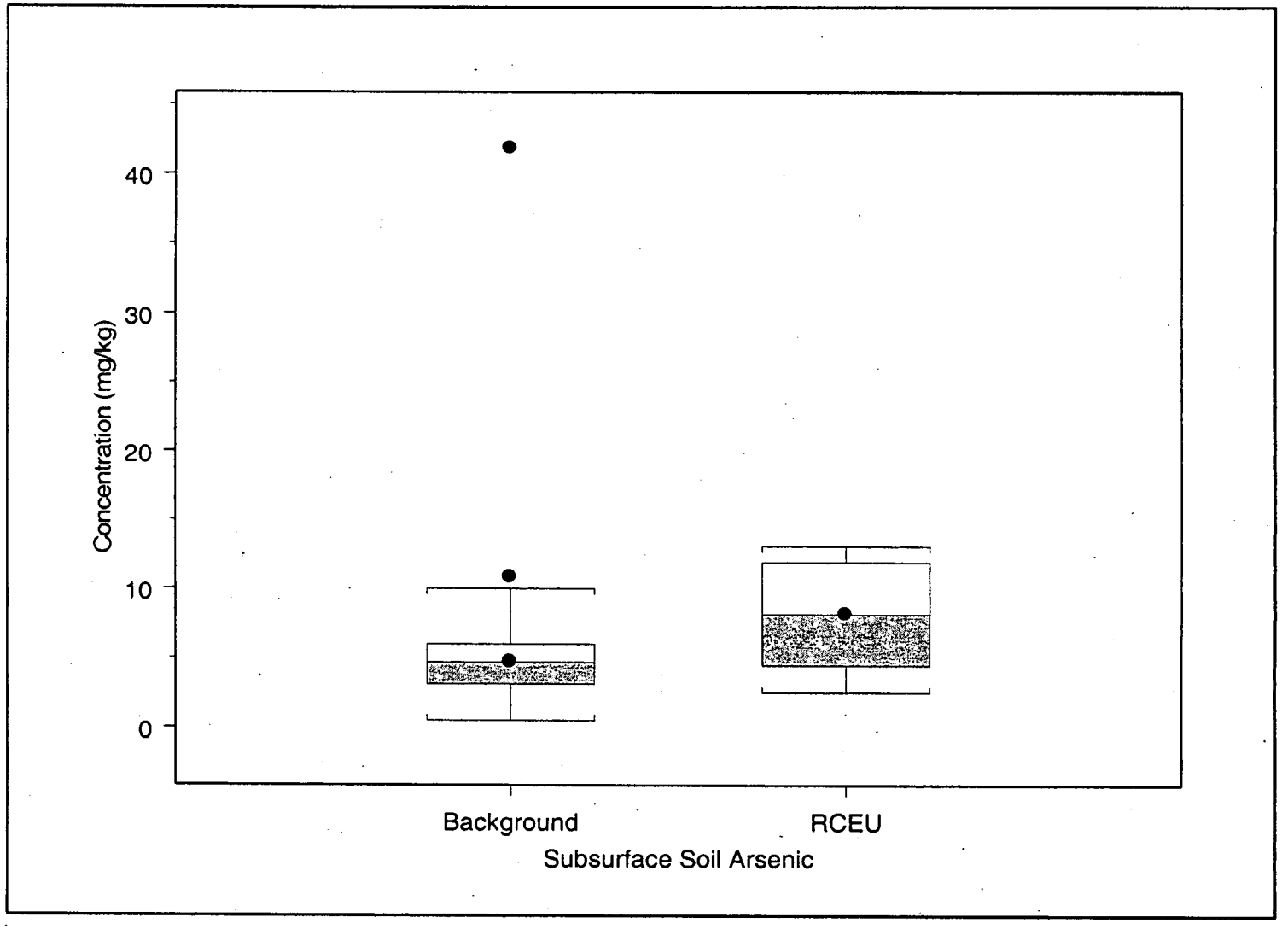
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure 2.2
RCEU Surface Soil/Surface Sediment Box Plots for Arsenic



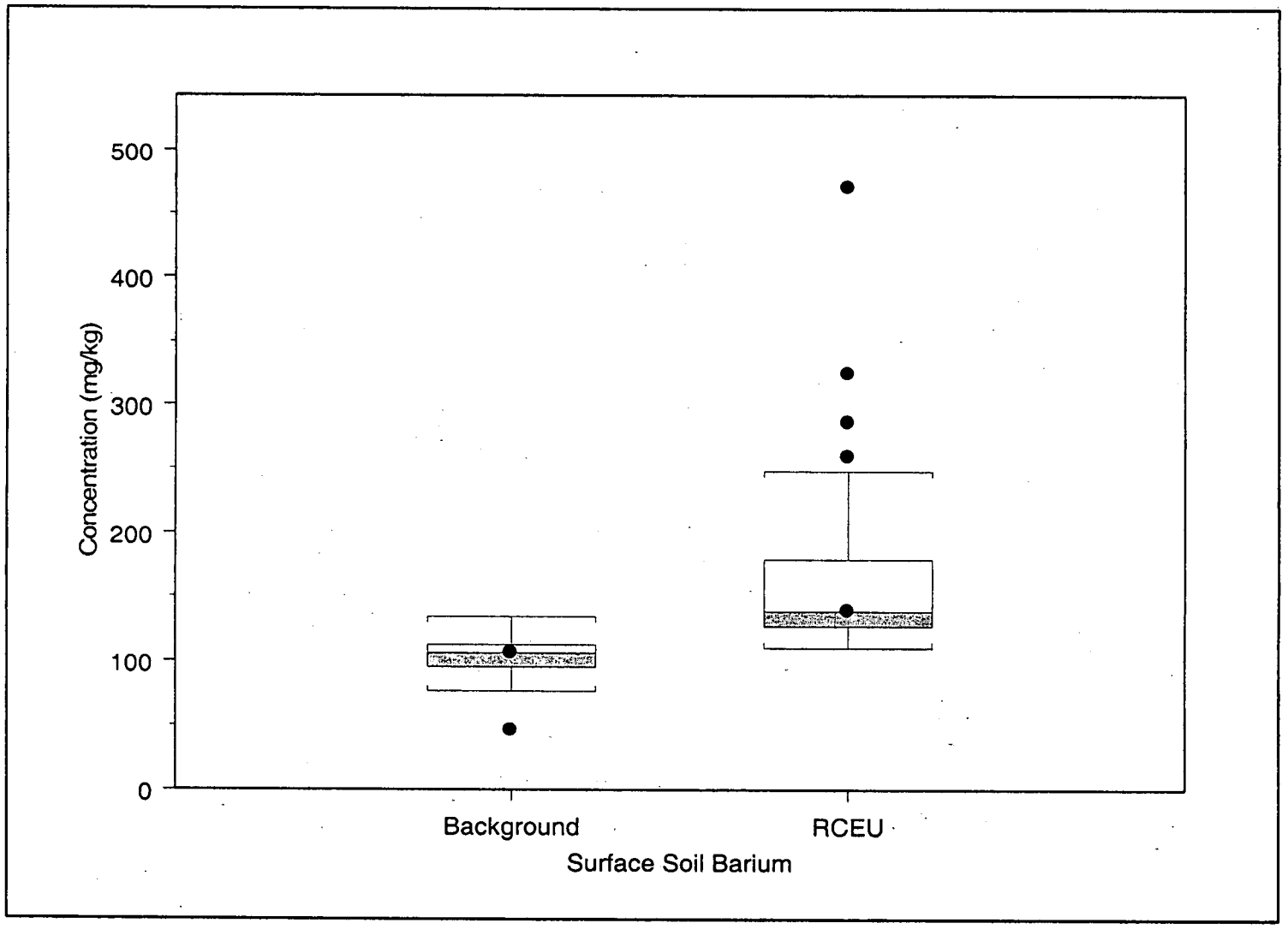
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure 5.2.3
RCEU Subsurface Soil Box Plots for Arsenic



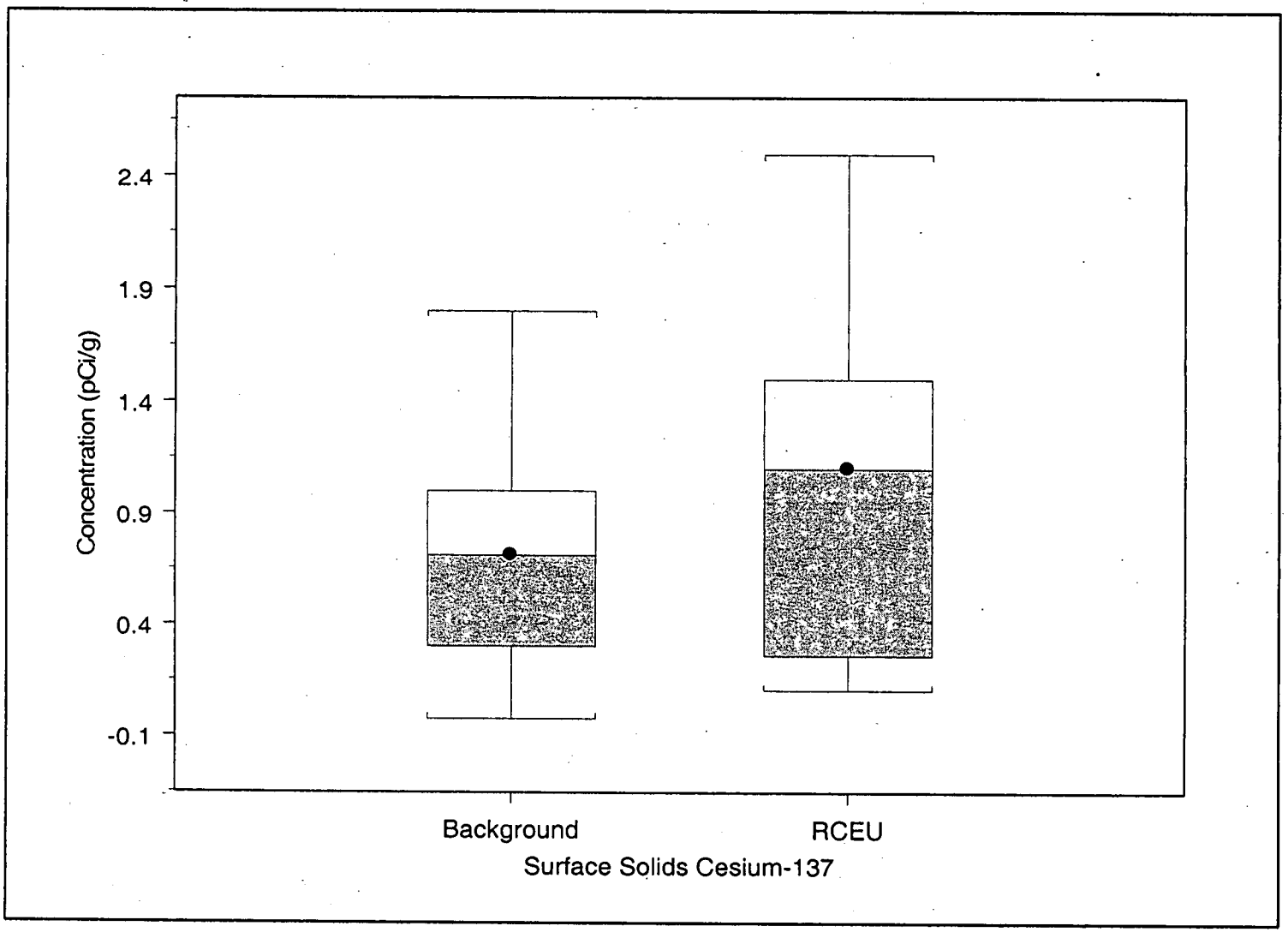
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure 2.4
RCEU Surface Soil Box Plots for Barium



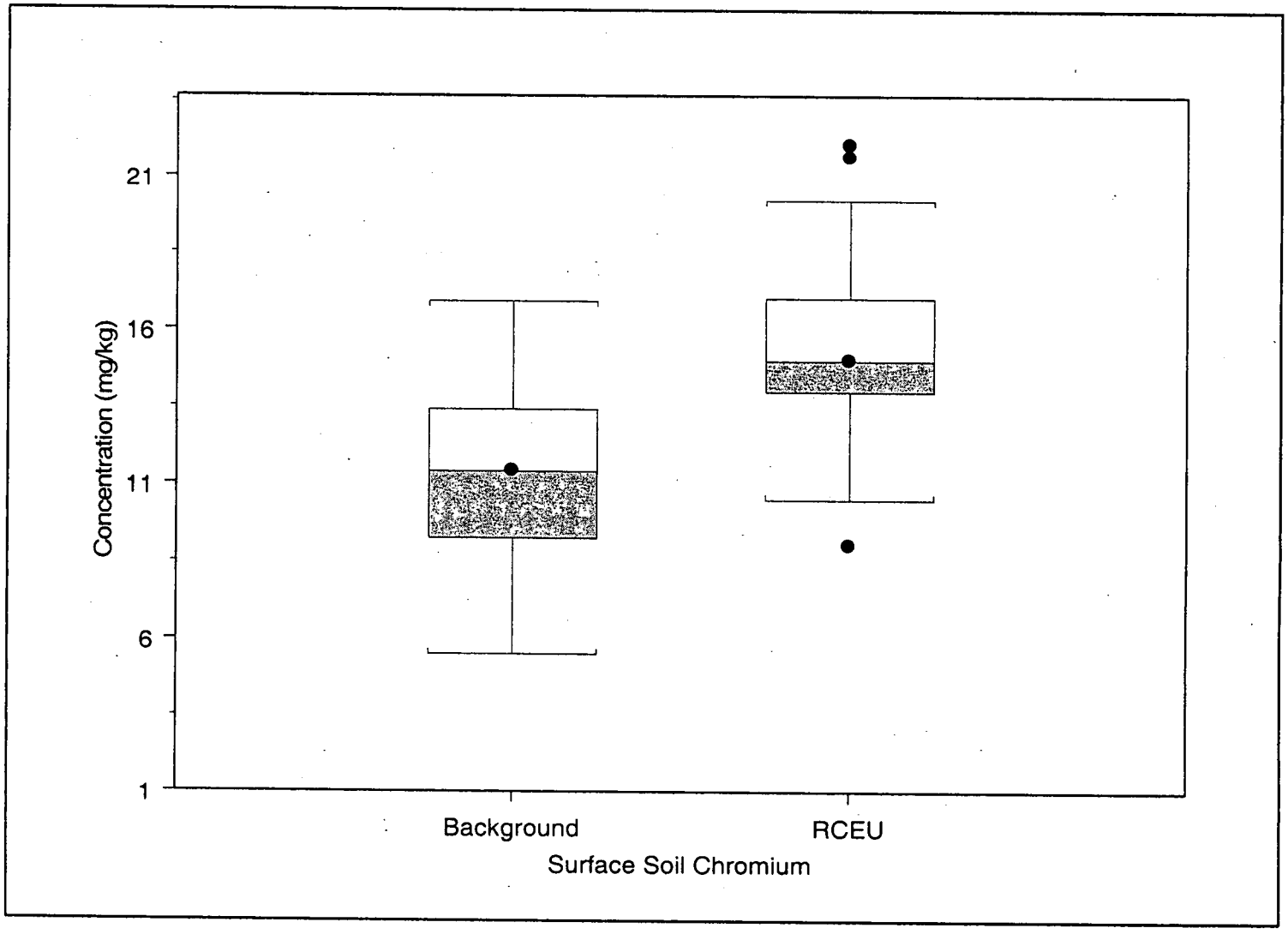
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure 2.5
RCEU Surface Soil/Surface Sediment Box Plots for Cesium-137



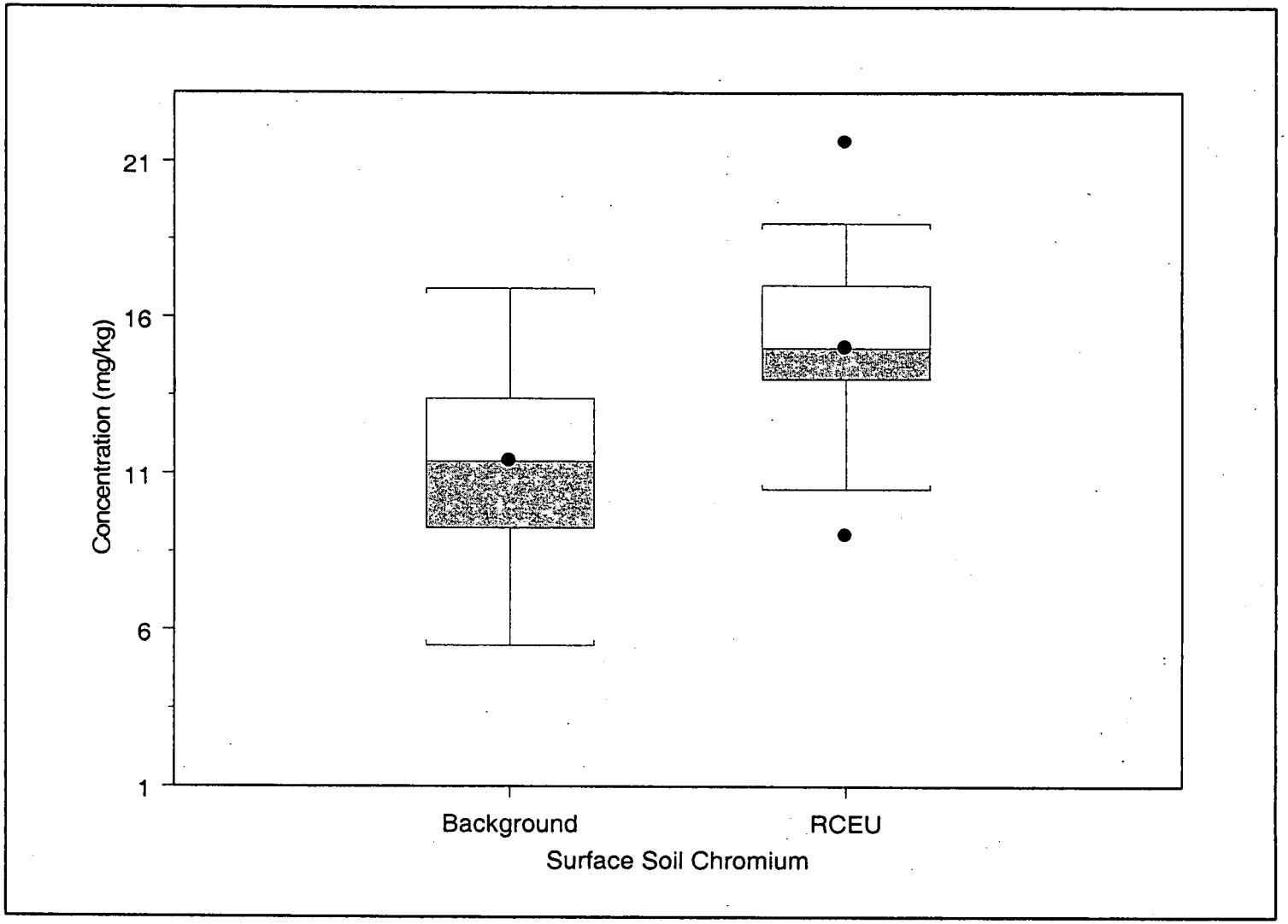
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure 2.6
RCEU Surface Soil Box Plots for Chromium



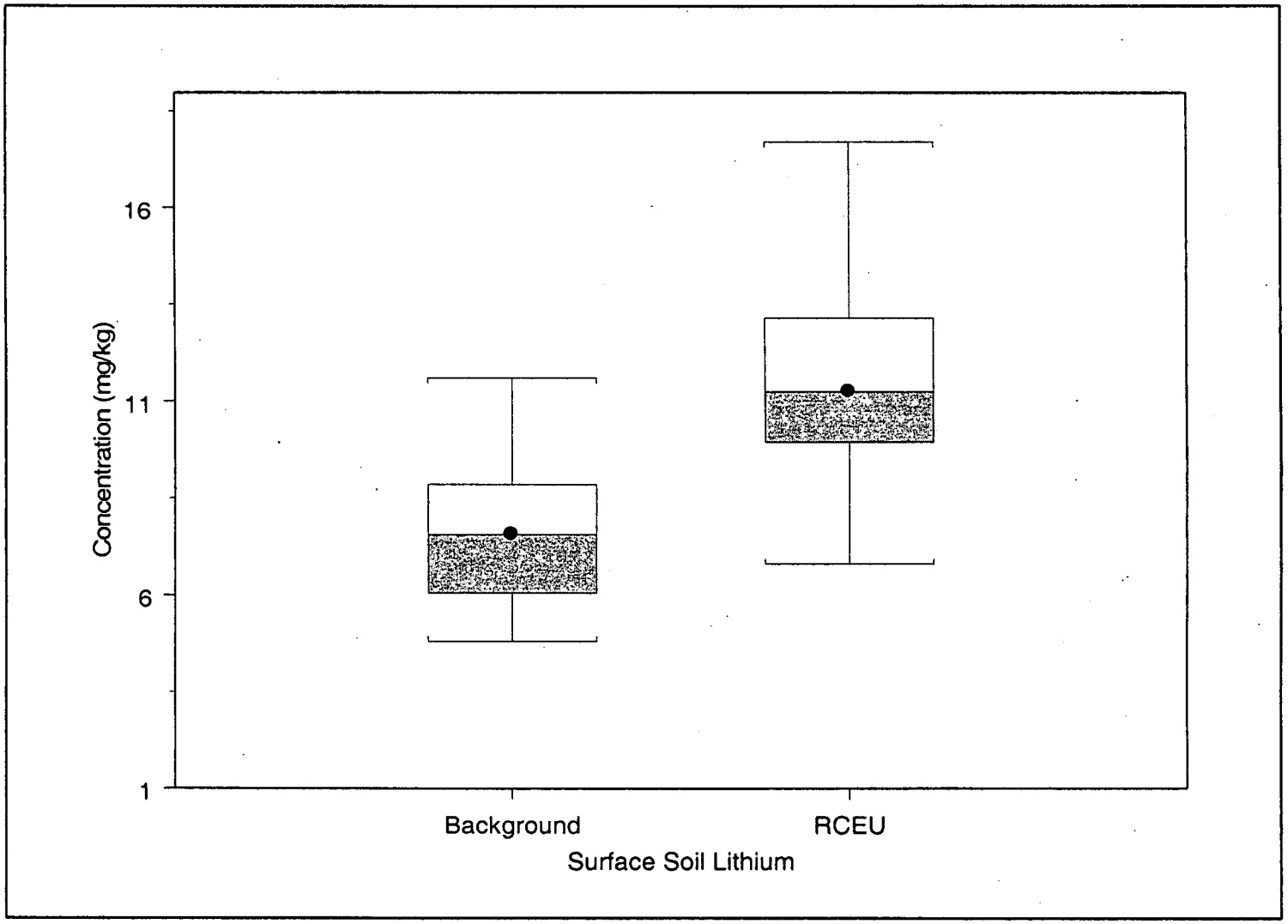
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure 2.7
RCEU Surface Soil in PMJM Habitat Box Plots for Chromium



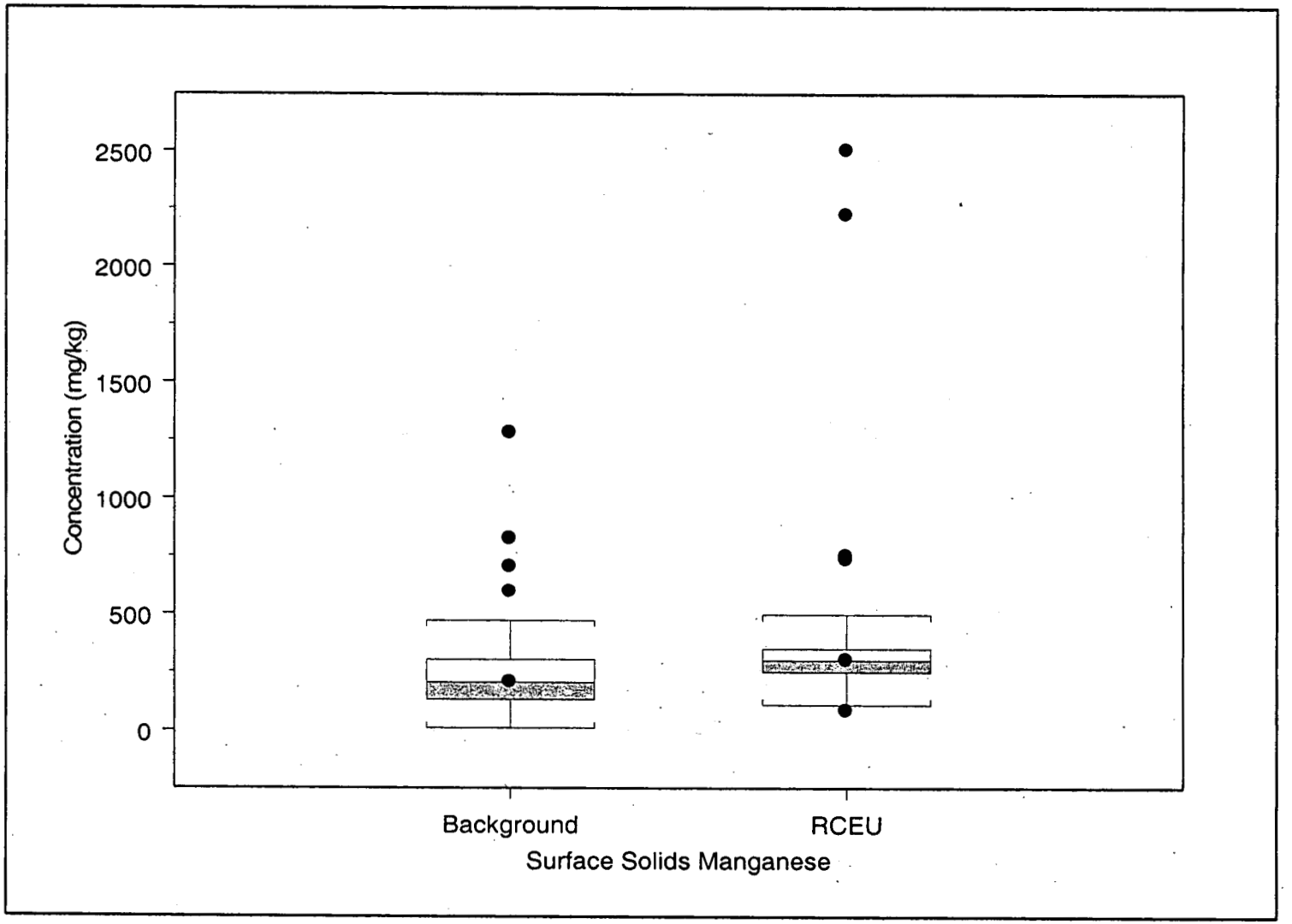
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure 2.8
RCEU Surface Soil Box Plots for Lithium



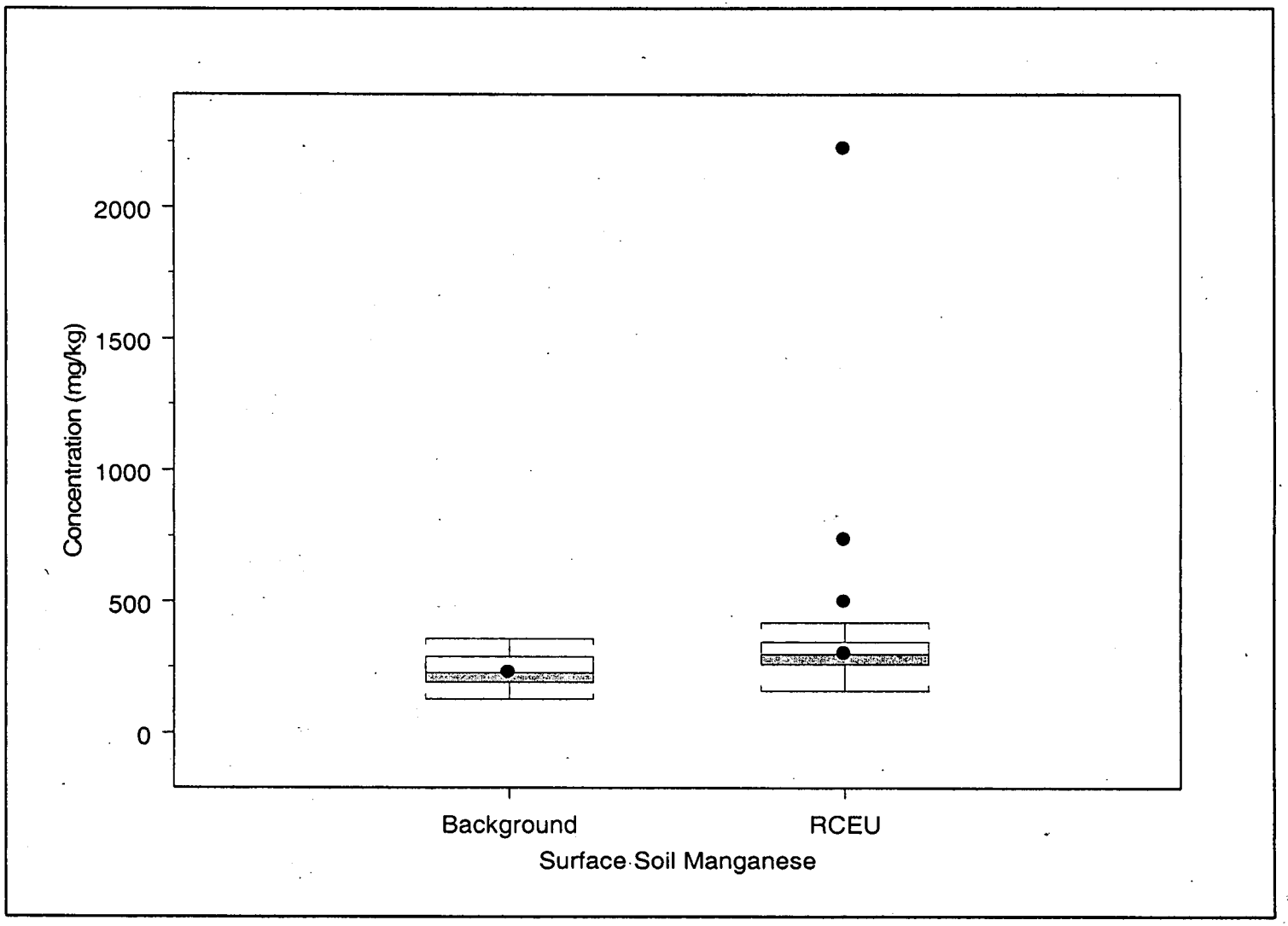
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure 2.2.9
RCEU Surface Soil/Surface Sediment Box Plots for Manganese



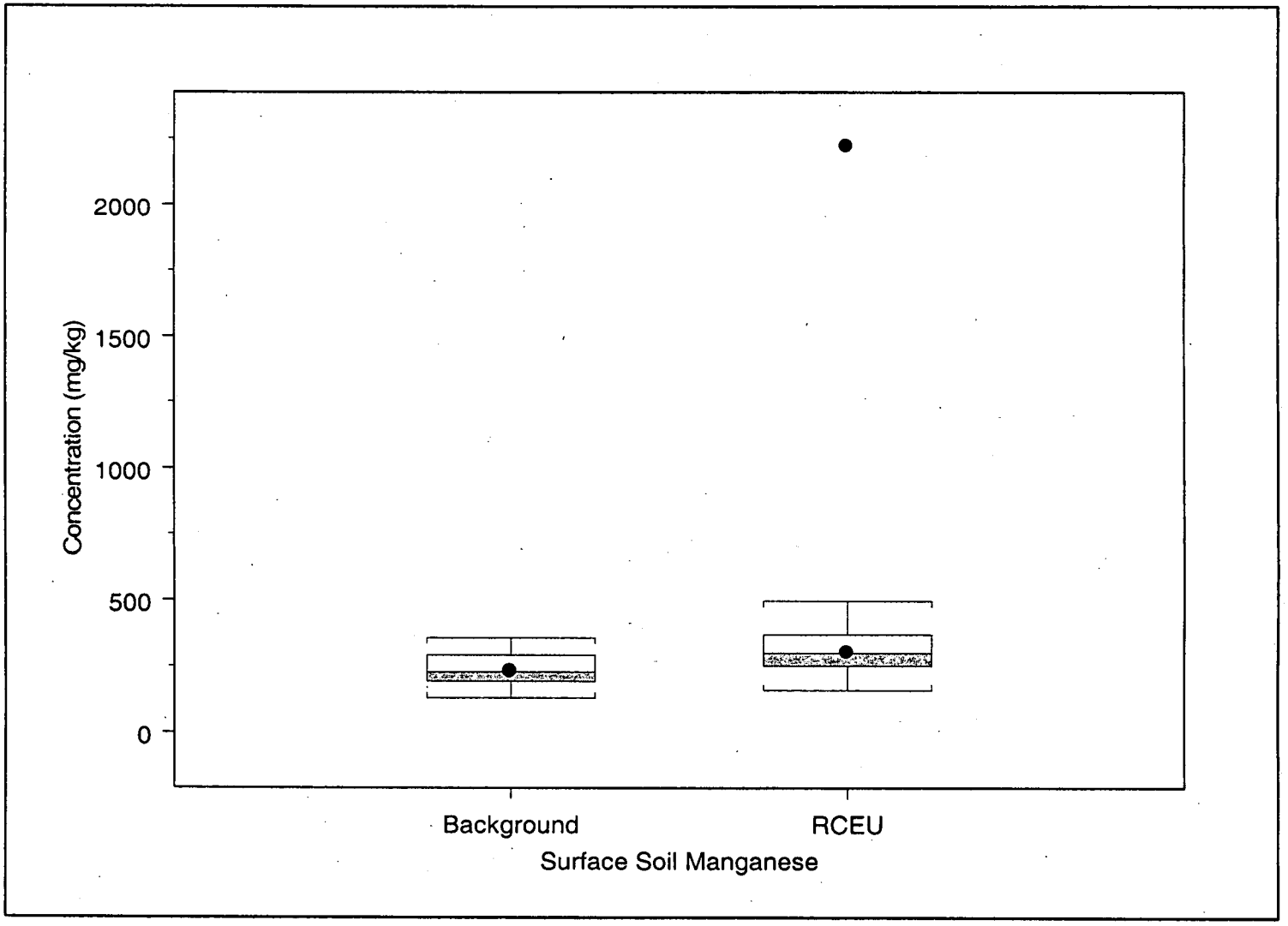
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A-10
RCEU Surface Soil Box Plots for Manganese



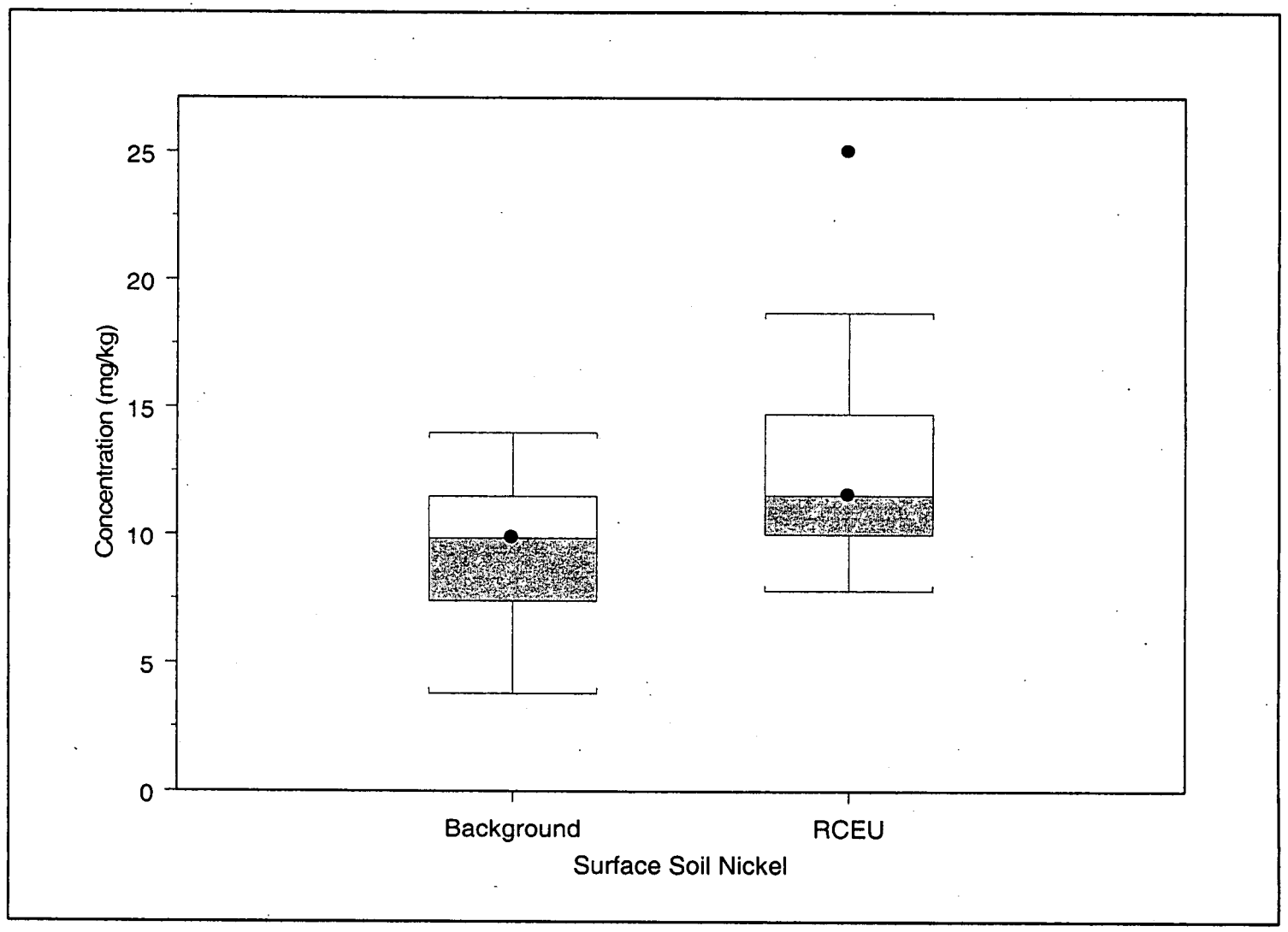
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure 2.11
RCEU Surface Soil in PMJM Habitat Box Plots for Manganese



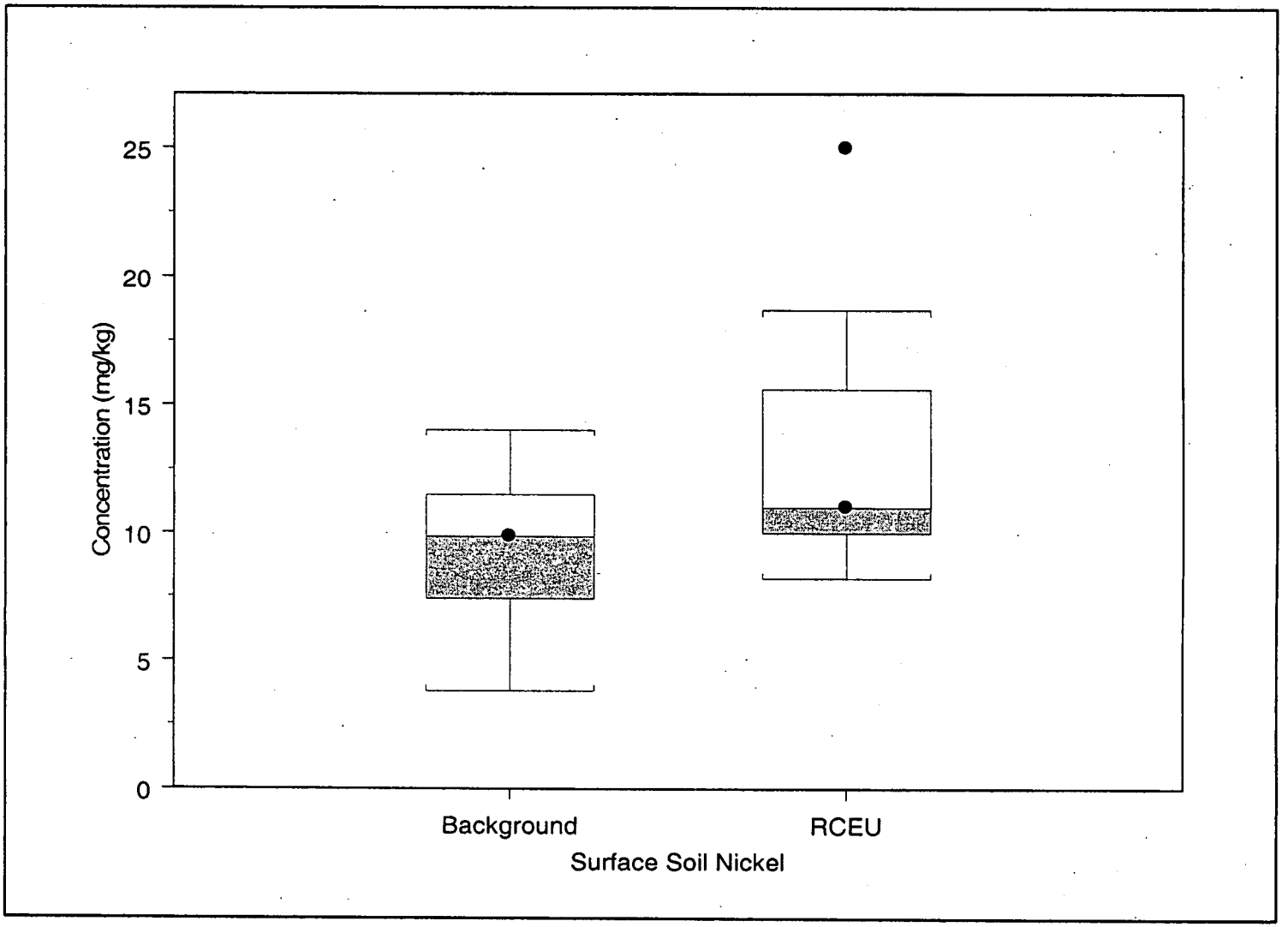
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure .12
RCEU Surface Soil Box Plots for Nickel



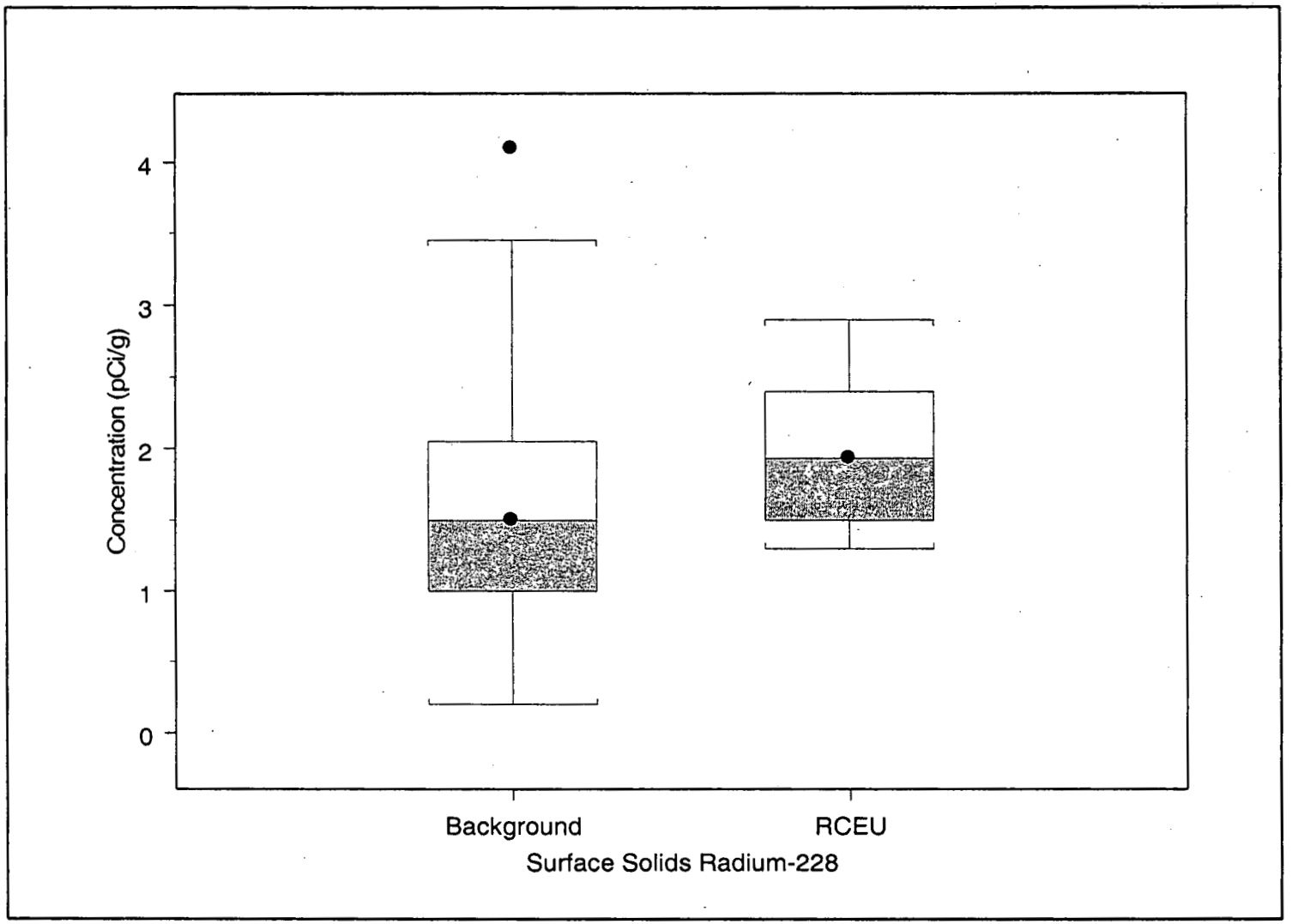
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure 2.13
RCEU Surface Soil in PMJM Habitat Box Plots for Nickel



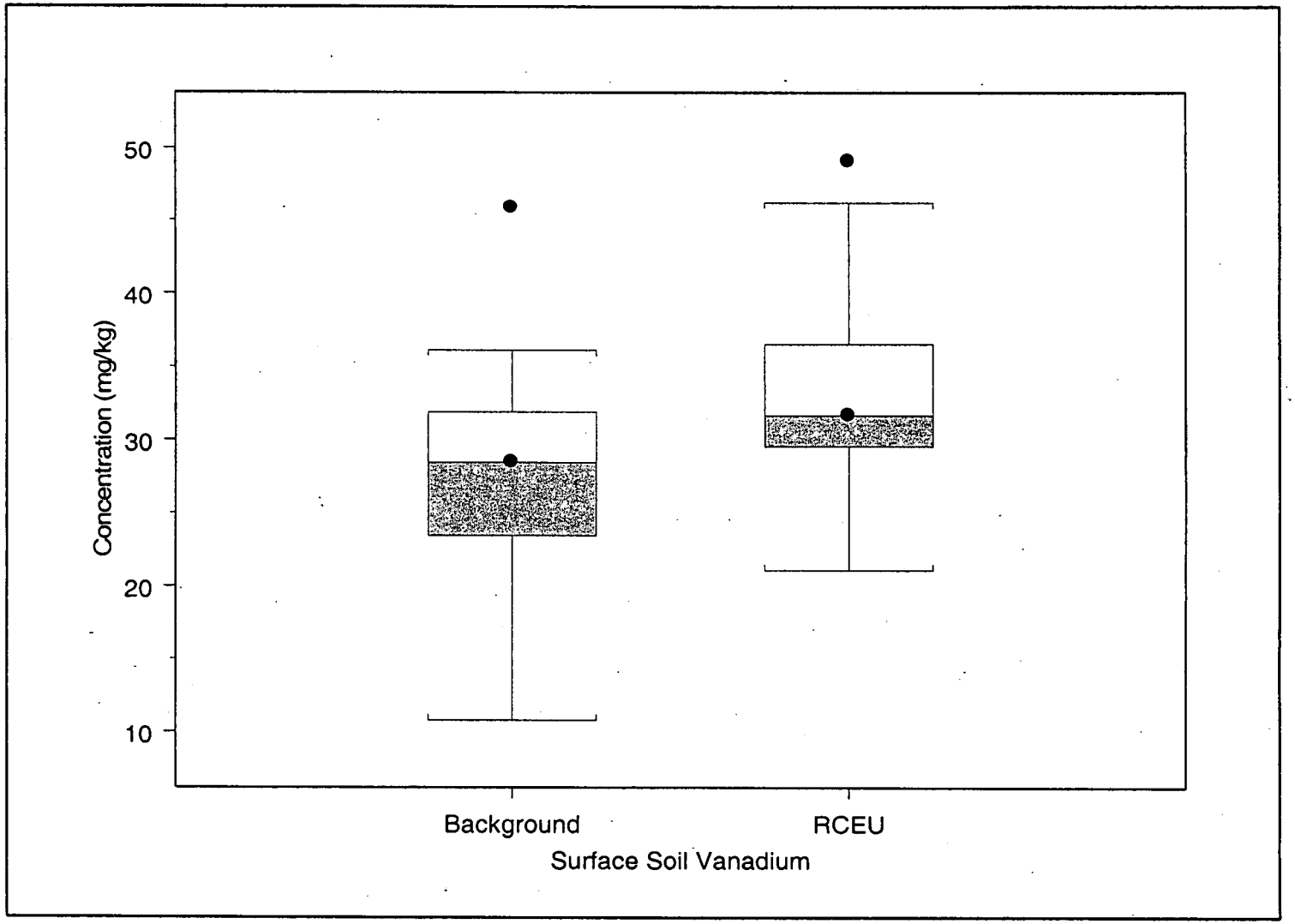
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure 2.14
RCEU Surface Soil/Surface Sediment Box Plots for Radium-228



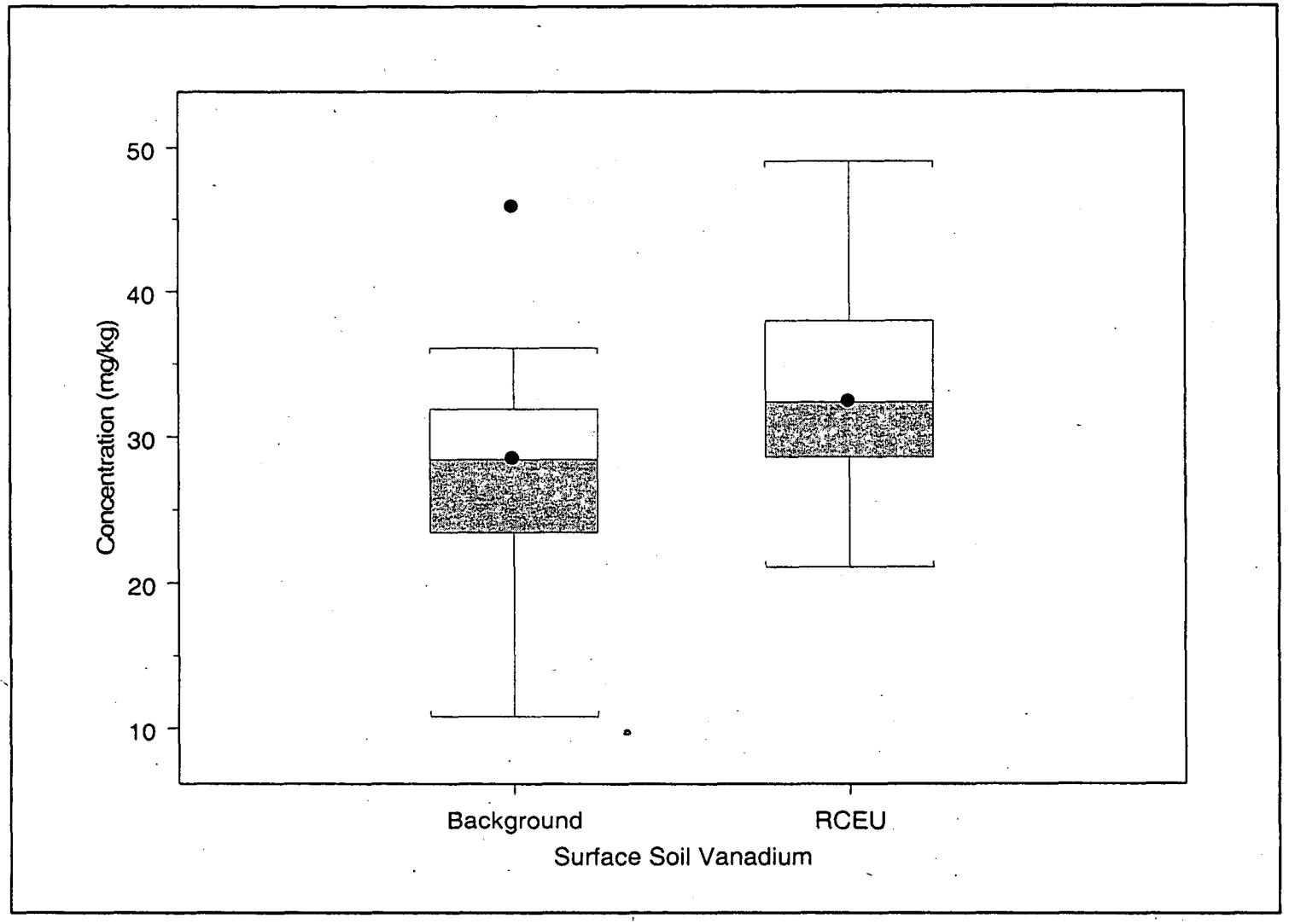
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A-15
RCEU Surface Soil Box Plots for Vanadium



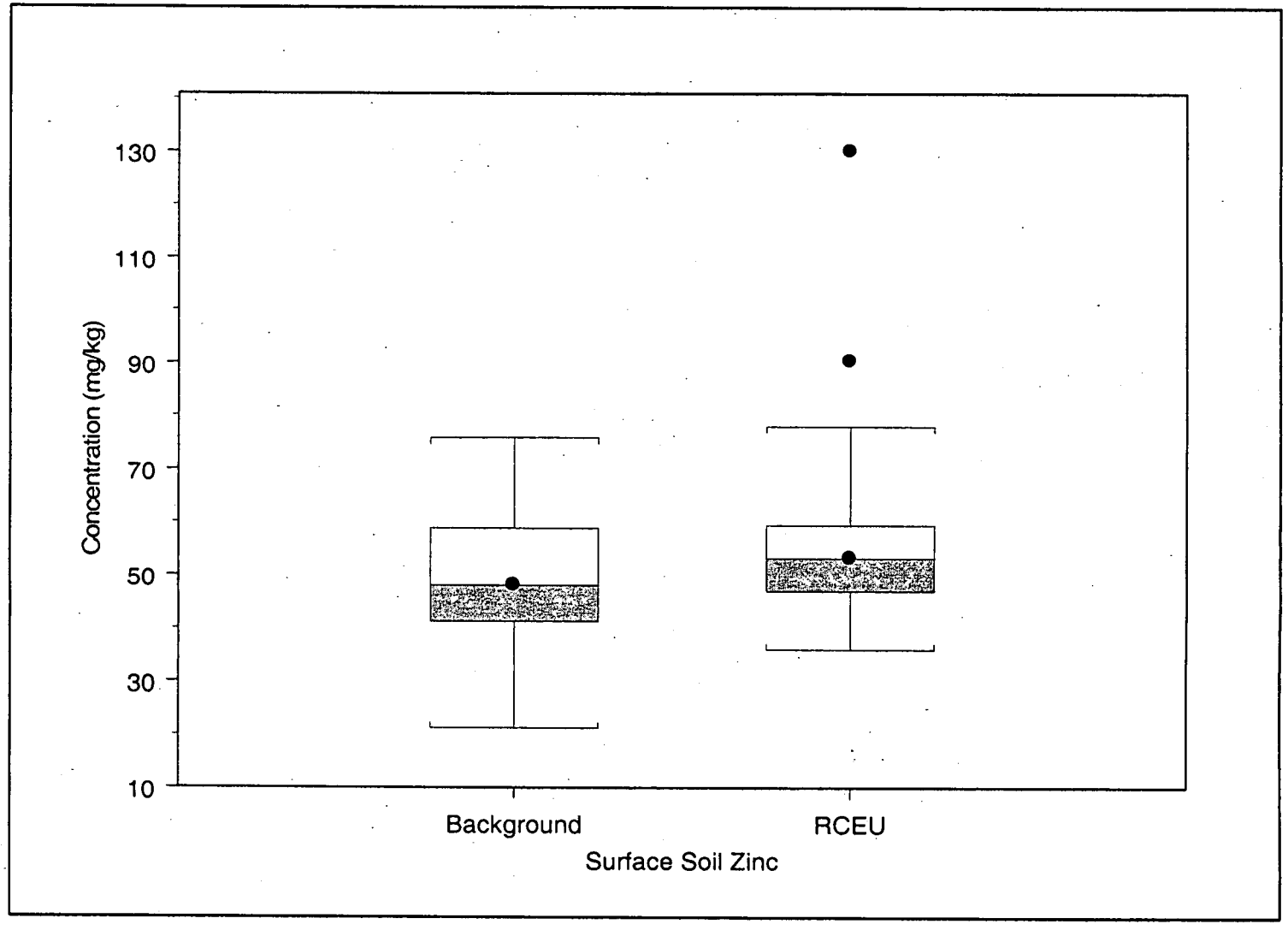
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure [illegible].16
RCEU Surface Soil in PMJM Habitat Box Plots for Vanadium



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure [illegible].17
RCEU Surface Soil Box Plots for Zinc



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

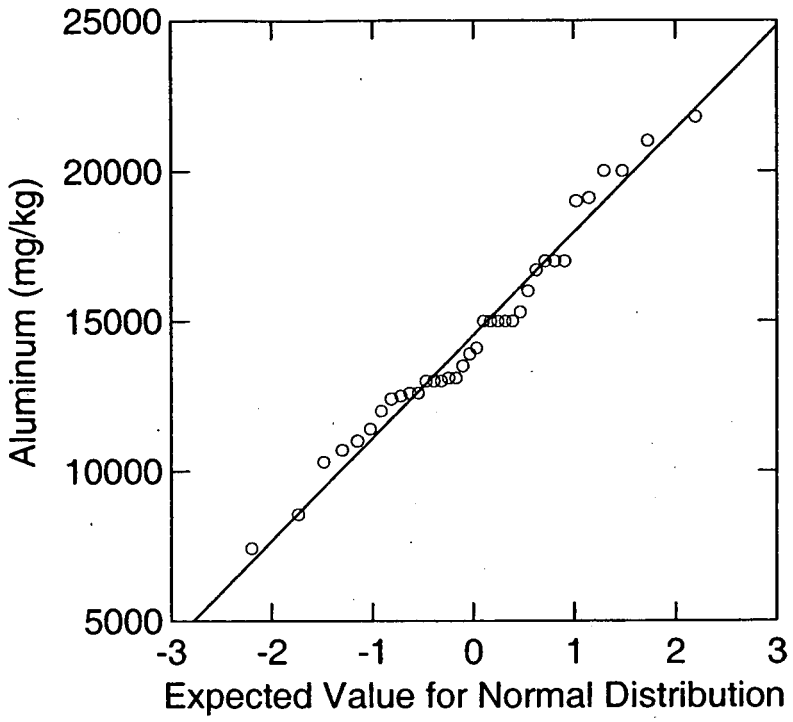


Figure A3.4.1. Probability Plot for Aluminum Concentrations in RCEU Surface Soil

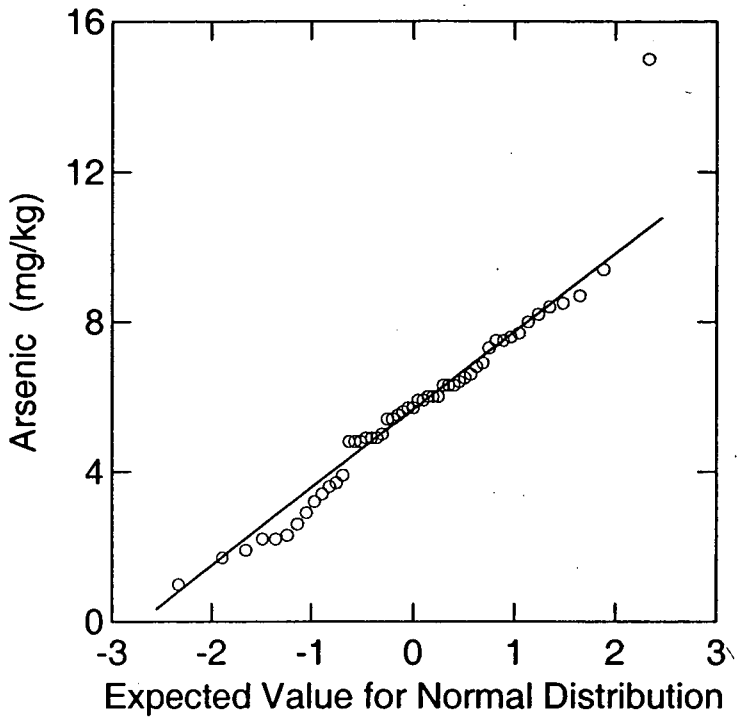


Figure A3.4.2. Probability Plot for Arsenic Concentrations in RCEU Surface Soil/Surface Sediment

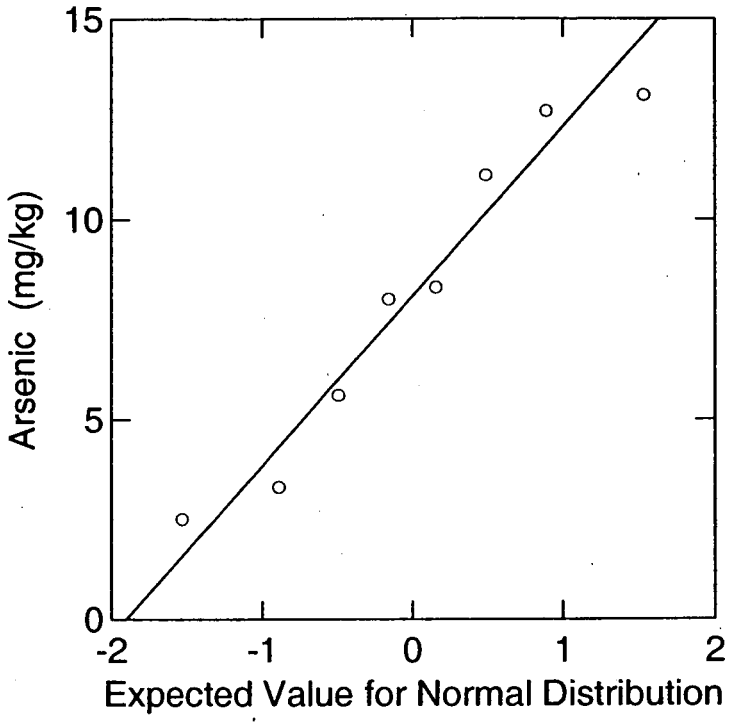


Figure A3.4.3. Probability Plot for Arsenic Concentrations in RCEU Subsurface Soils

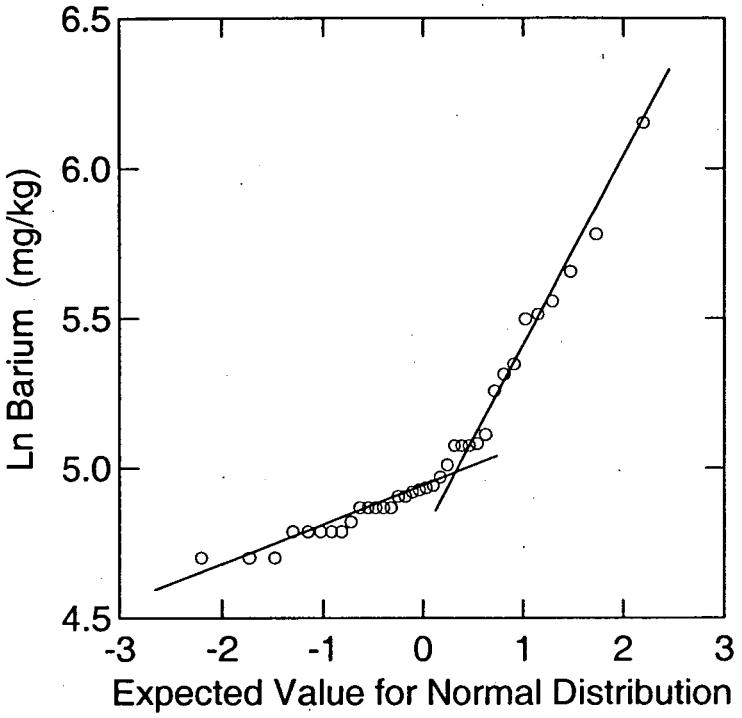


Figure A3.4.4. Probability Plot for Barium Concentrations (Natural Logarithm) in RCEU Surface Soil

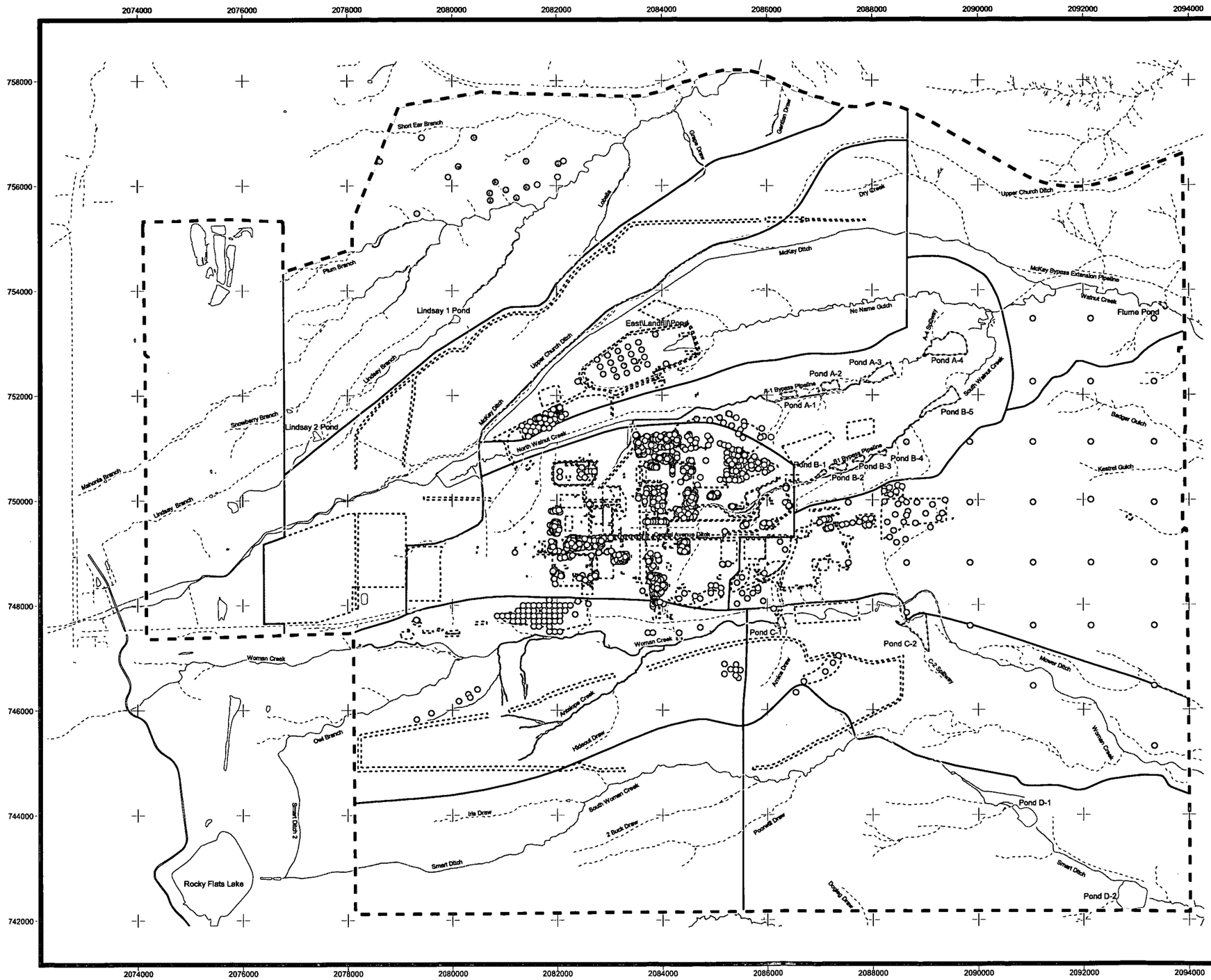


Figure A3.4.5

Bis(2-ethylhexyl)phthalate Concentrations in Sitewide Surface Soil (Non-PMJM)

KEY

- Concentration > 3x ESL
- Concentration > ESL and <= 3x ESL
- Concentration <= ESL
- Nondetect (ND)

Min. Non-PMJM ESL = 137 ug/kg
3 x Min. Non-PMJM ESL = 410 ug/kg

Standard Map Features

- Rock Creek Drainage EU
- Exposure Unit boundaries
- Former building where analyte was used or generated as waste
- Historical IHSS/PAC
- Pond
- Ephemeral stream
- Intermittent stream
- Perennial stream
- Site boundary

N
W E
S

0 1000 2000 Feet

Scale 1:24,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

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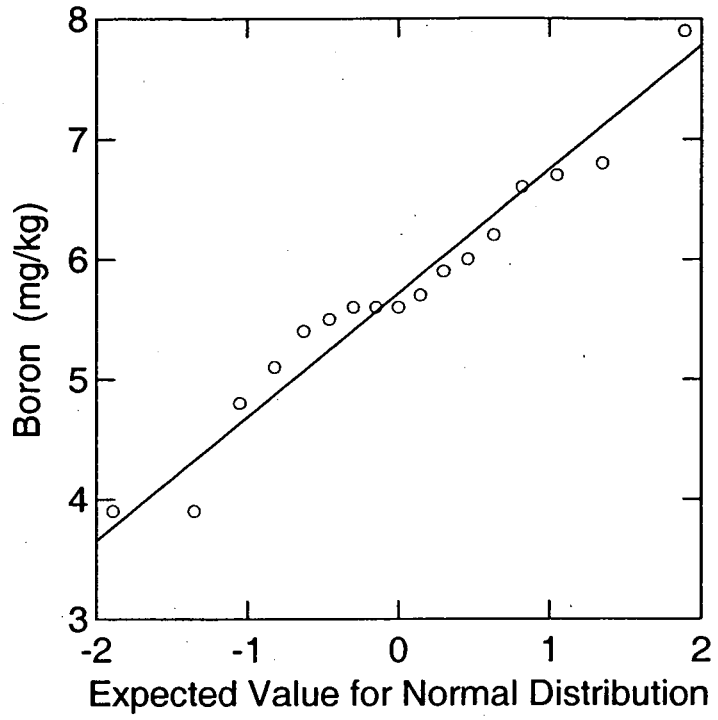

Figure A3.4.6. Probability Plot for Boron Concentrations in RCEU Surface Soil

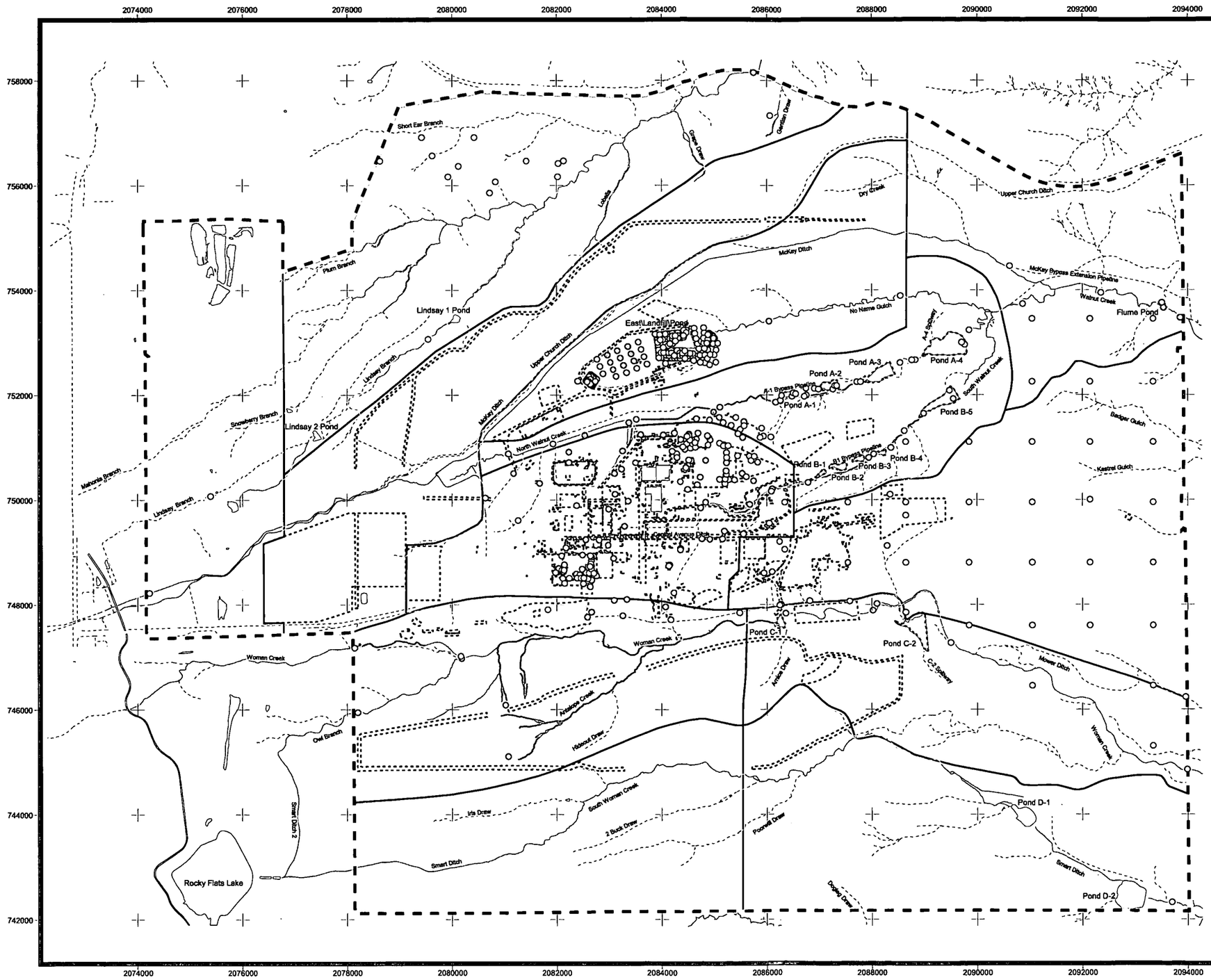

Figure A3.4.7

Cesium-137 Activity in Sitewide Surface Soil/Surface Sediment

KEY

- Concentration > 3x Background MDC
- Concentration > Background MDC and <= 3x Background MDC
- Concentration > WRW PRG and <= Background MDC
- Concentration <= WRW PRG
- Nondetect (ND)

WRW PRG = 0.221 pCi/g
Background MDC = 1.80 pCi/g
3 x Background MDC = 5.4 pCi/g

Standard Map Features

- Rock Creek Drainage EU
- Exposure Unit boundaries
- Former building where analyte was used or generated as waste
- Historical IHSS/PAC
- Pond
- Ephemeral stream
- Intermittent stream
- Perennial stream
- Site boundary

N W E S

0 1000 2000 Feet

Scale 1:24,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

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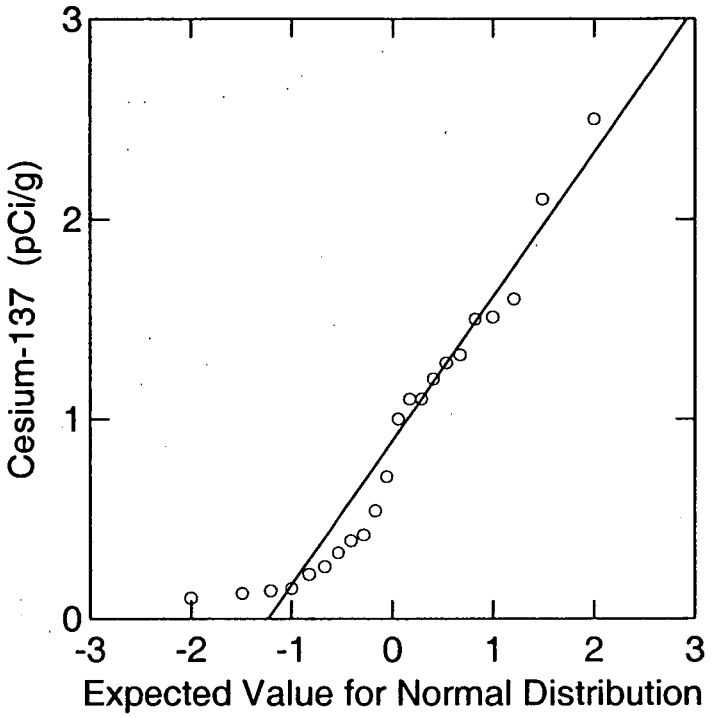

Figure A3.4.8. Probability Plot for Cesium-137 Activities in RCEU Surface Soil/Surface Sediment

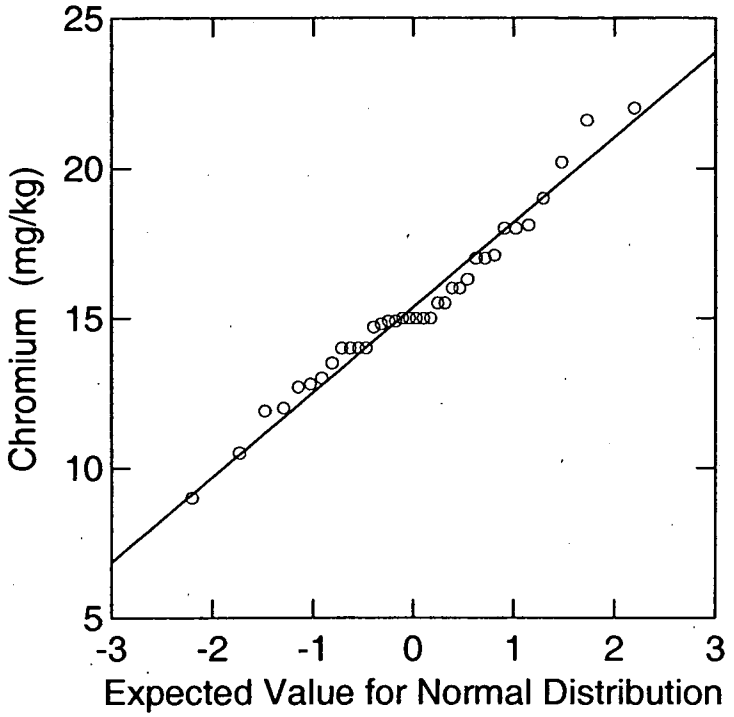

Figure A3.4.9. Probability Plot for Chromium Concentrations in RCEU Surface Soil

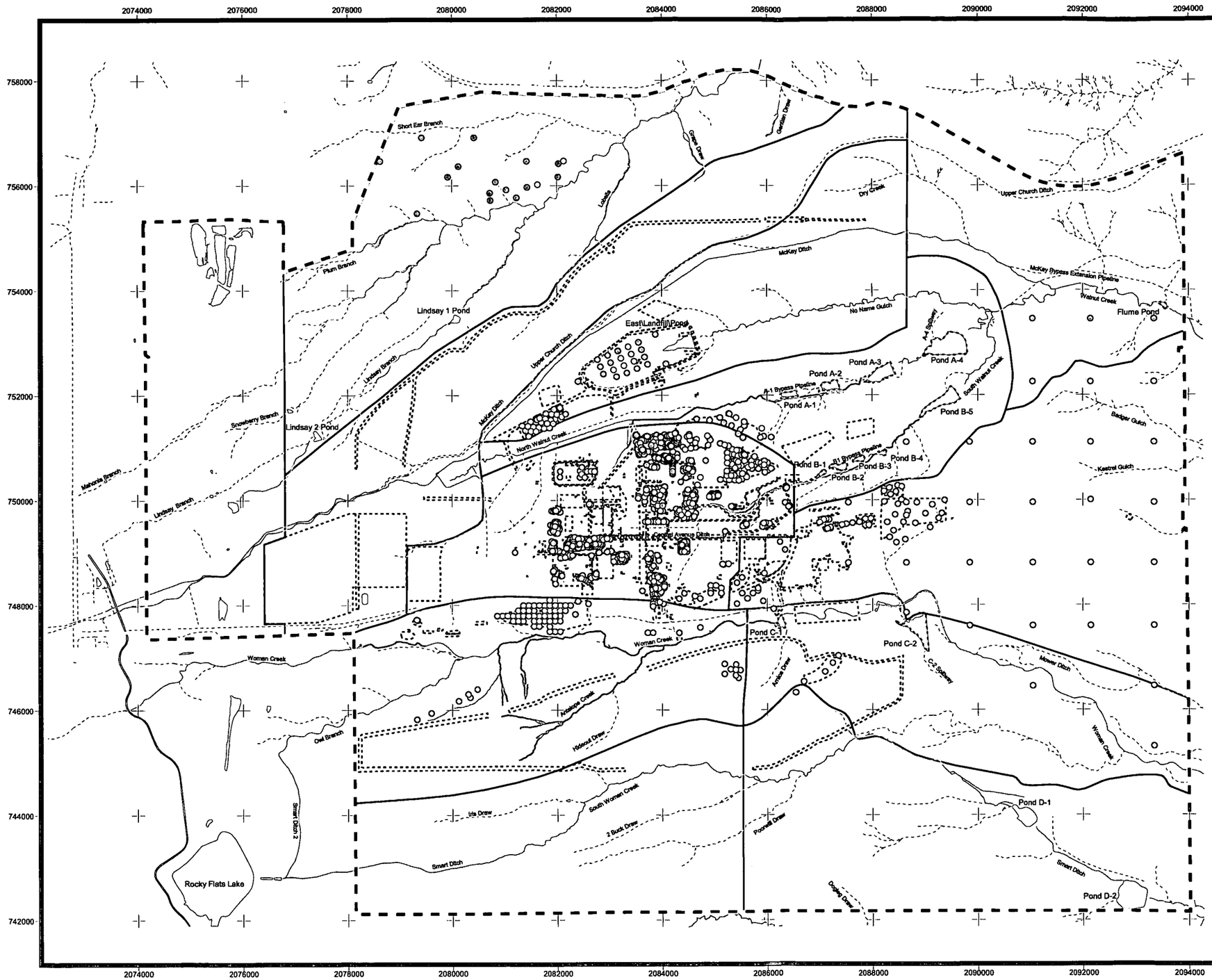

Figure A3.4.10

Di-n-butylphthalate Concentrations in Sitewide Surface Soil (Non-PMJM)

KEY

- Concentration > 3x ESL
- Concentration > ESL and <= 3x ESL
- Concentration <= ESL
- Nondetect (ND)

Min. Non-PMJM ESL = 15.9 ug/kg
3 x Min. Non-PMJM ESL = 47.6 ug/kg

Standard Map Features

- Rock Creek Drainage EU
- Exposure Unit boundaries
- Former building where analyte was used or generated as waste
- Historical IHSS/PAC
- Pond
- Ephemeral stream
- Intermittent stream
- Perennial stream
- Site boundary

N
W E
S

0 1000 2000 Feet

Scale 1:24,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
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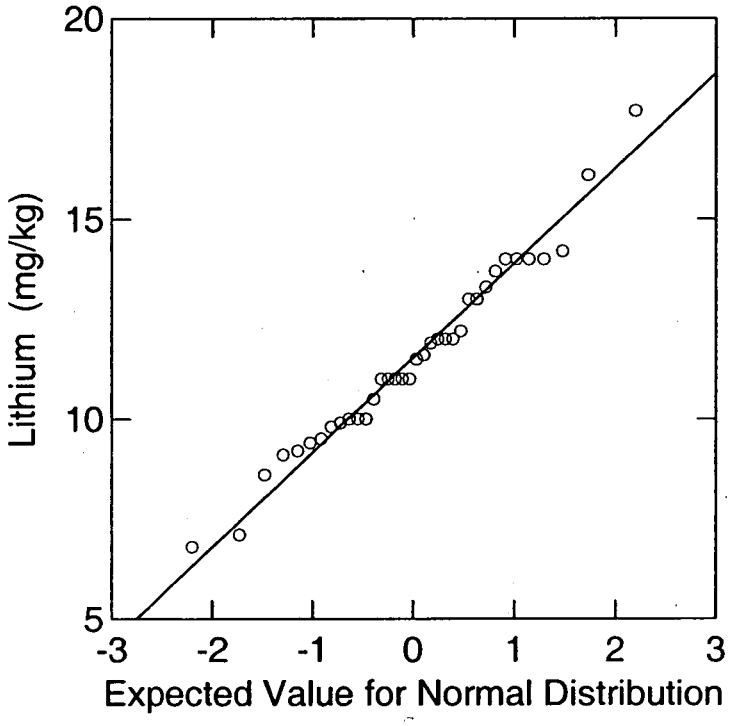

Figure A3.4.11. Probability Plot of Lithium Concentrations in RCEU Surface Soil

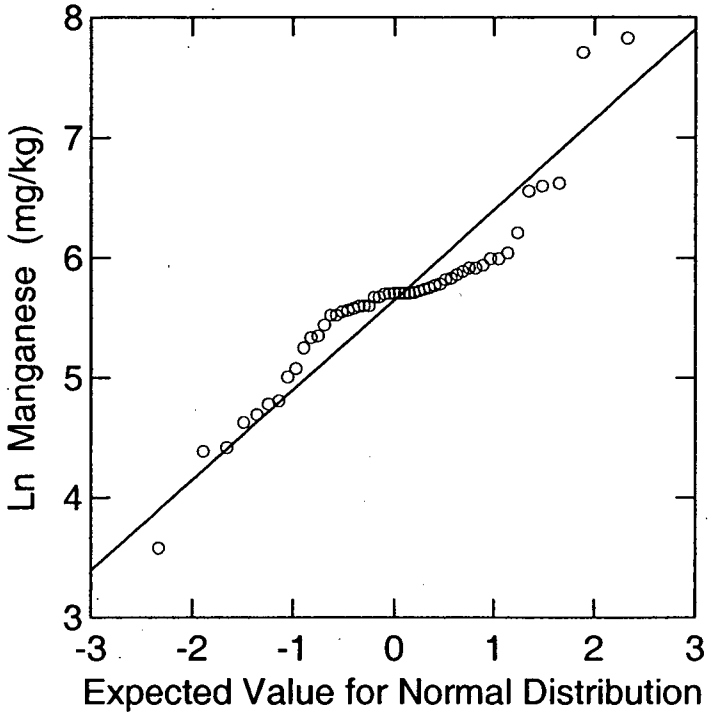

Figure A3.4.12. Probability Plot for Manganese Concentrations (Natural Logarithm) in RCEU Surface Soil/Surface Sediment Data

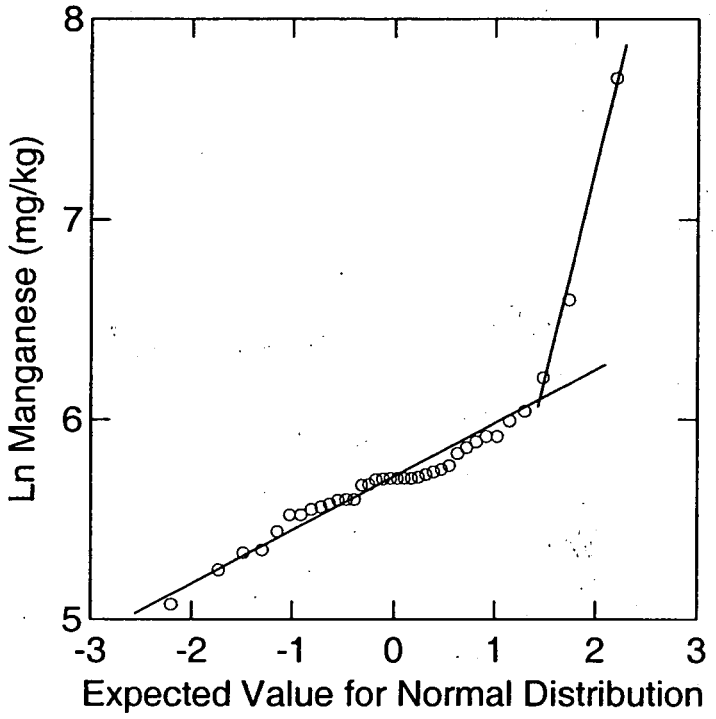

Figure A3.4.13. Probability Plot for Manganese Concentrations (Natural Logarithm) in RCEU Surface Soil

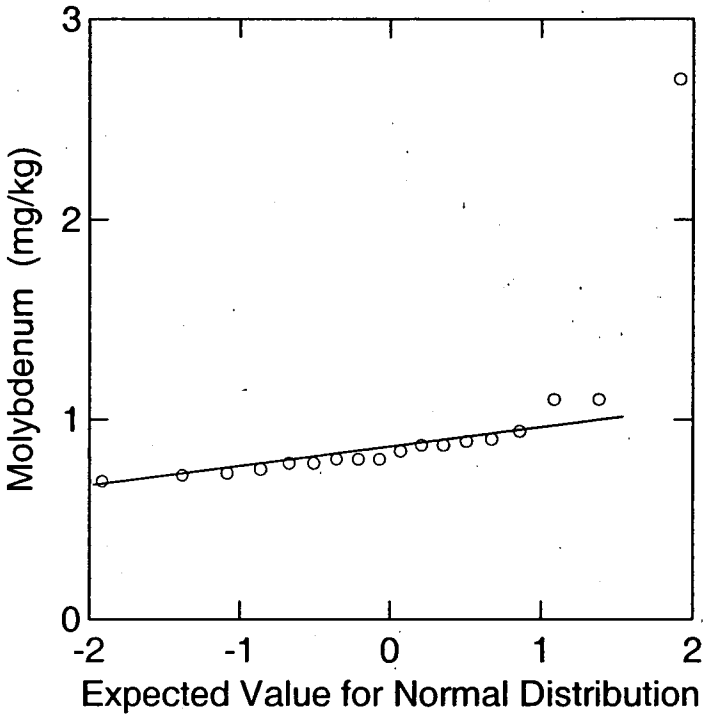

Figure A3.4.14. Probability Plot of Detected Molybdenum Concentrations in RCEU Surface Soil (nondetect values removed)

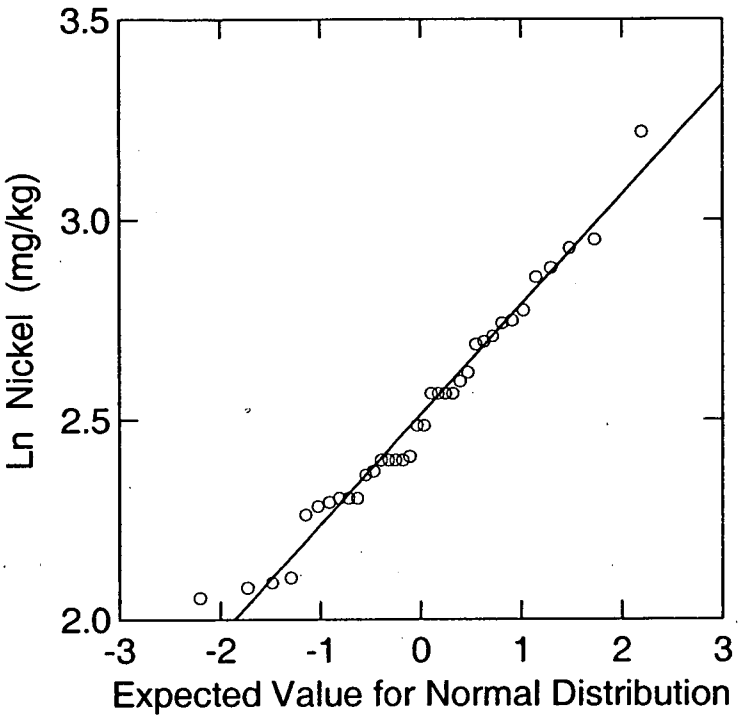

Figure A3.4.15. Probability Plot for Nickel Concentrations (Natural Logarithm) in RCEU Surface Soil

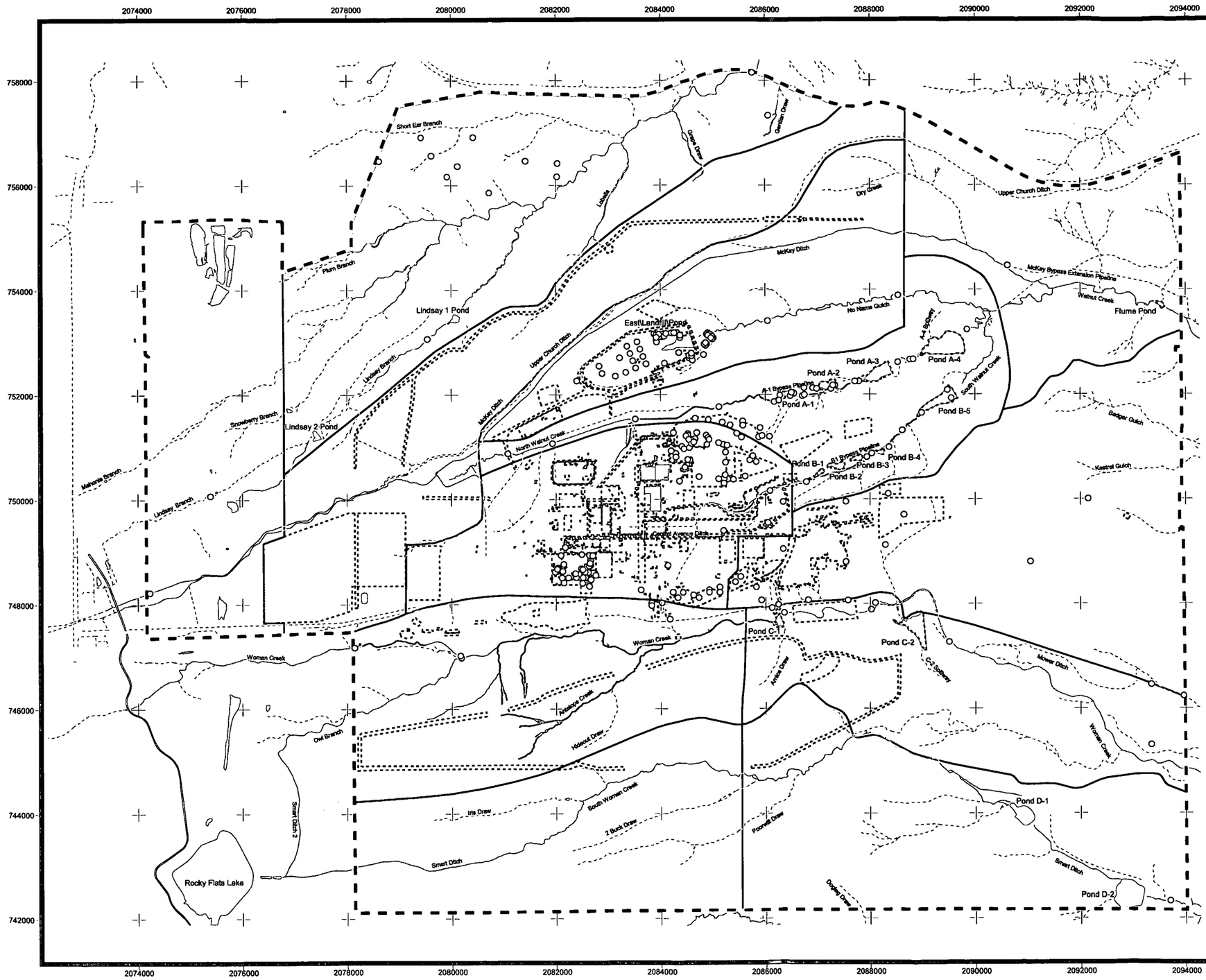

Figure A3.4.16

Radium-228 Activity in Sitewide Surface Soil/Surface Sediment

KEY

- Concentration > 3x Background MDC
- Concentration > Background MDC and <= 3x Background MDC
- Concentration > WRW PRG and <= Background MDC
- Concentration <= WRW PRG
- Nondetect (ND)

WRW PRG = 0.111 pCi/g
Background MDC = 4.10 pCi/g
3 x Background MDC = 12.3 pCi/g

Standard Map Features

- Rock Creek Drainage EU
- Exposure Unit boundaries
- Former building where analyte was used or generated as waste
- Historical IHSS/PAC
- Pond
- Ephemeral stream
- Intermittent stream
- Perennial stream
- Site boundary

N
W E
S

0 1000 2000 Feet

Scale 1:24,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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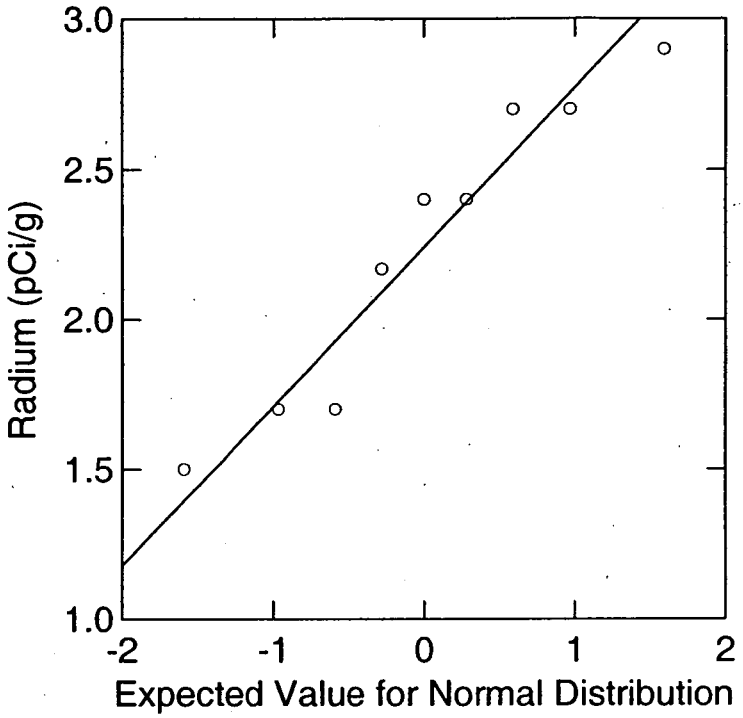

Figure A3.4.17. Probability Plot for Radium-228 Activities in RCEU Surface Soil/Surface Sediment Data

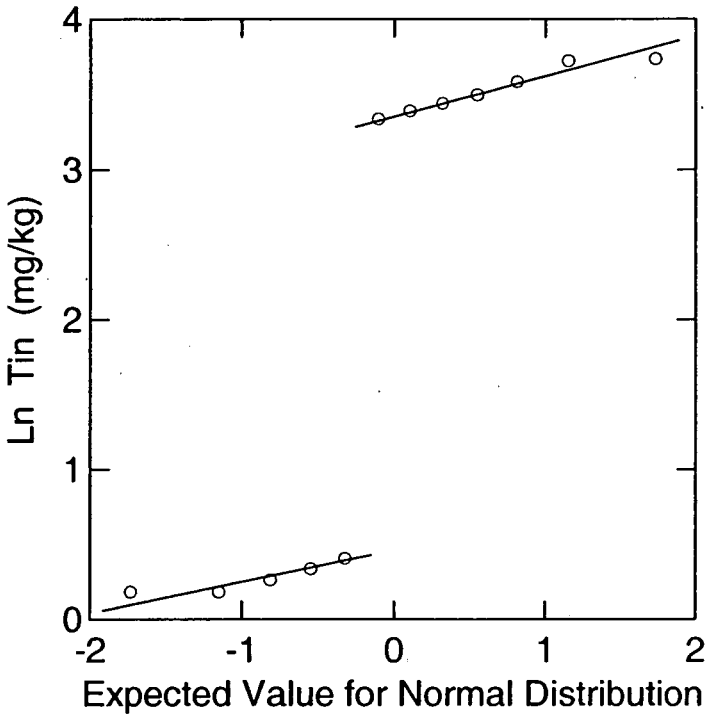

Figure A3.4.18. Probability Plot for Detected Tin Concentrations (Natural Logarithm) in RCEU Surface Soil (nondetect values removed)

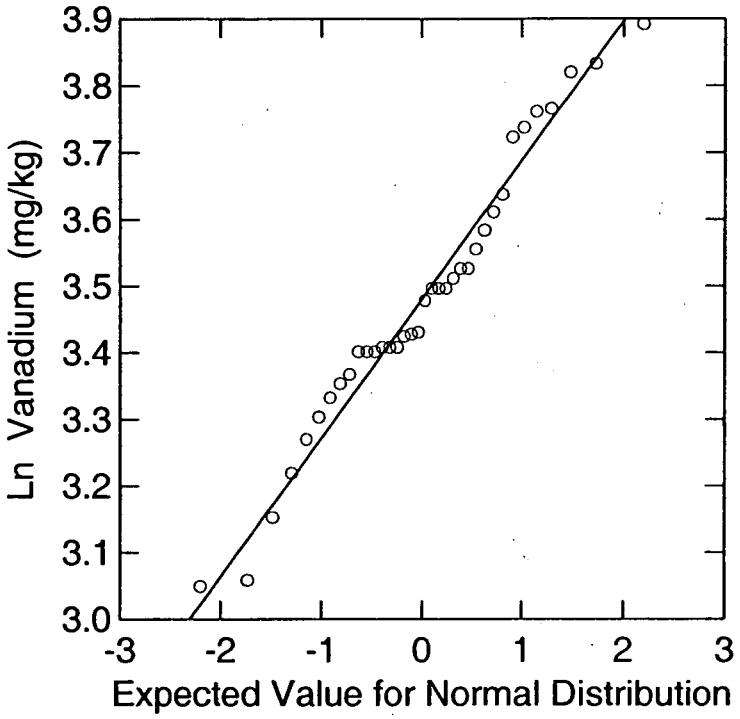

Figure A3.4.19. Probability Plot for Vanadium Concentrations (Natural Logarithm) in RCEU Surface Soil

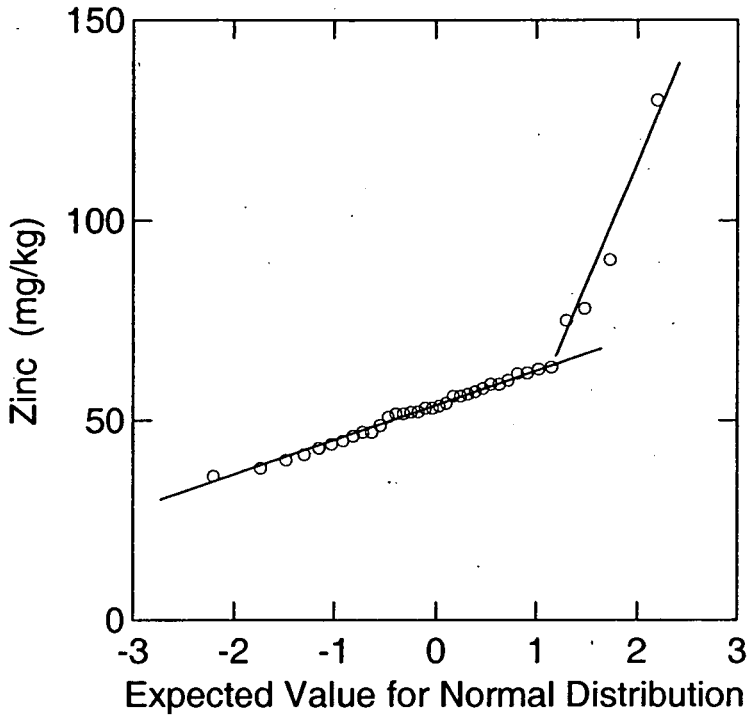

Figure A3.4.20. Probability Plot for Zinc Concentrations in RCEU Surface Soils

COMPREHENSIVE RISK ASSESSMENT

ROCK CREEK DRAINAGE EXPOSURE UNIT

VOLUME 4: ATTACHMENT 4

CRA Analytical Data Set CD

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